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ABSTRACT

This document is a workbook for drafting students learning the basics of reading and interpreting electronic drawings and diagrams. The workbook contains eight units covering the following material: basic symbols; circuit symbols; electron tube symbols; winding symbols; semiconductor symbols; miscellaneous symbols; schematic diagrams; and connection diagrams. Final quizzes for each unit are included at the end of the workbook. Each unit contains an objective and performance indicators, introduction, information sheets, self-assessment quiz with answers provided, and a study guide including references for further information. The materials are illustrated with line drawings. (KC)

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ED204546

Drafting

Advanced Print Reading - Electronics

Basic Symbols

Circuit Symbols

Electron Tube Symbols

Winding Symbols

Semiconductor Symbols

Miscellaneous Symbols

Schematic Diagrams

Connection Diagrams

CE029457

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Drafting

Symbol Modifiers

Resistors

Capacitors

Antennas

Poiner Sources

Thermal Devices

Acoustic Devices

Goal:

The student will be able to identify basic graphic symbols used to indicate various electronic components.

Performance Indicators:

Given graphic illustrations of various electronic symbols, the student will identify them by the industry term.

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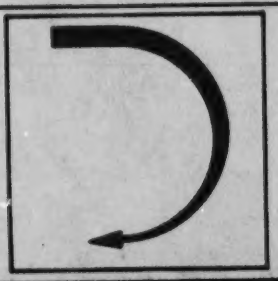
Introduction



INTRODUCTION:

Electronic and wiring or connection drawings are very complex. Because of this, a system of graphic symbols has been developed to save time and space on drawings. Each particular symbol has evolved from an elaborate drawing of the component. By simplifying these drawings, a symbol has been developed to represent that component in a circuit.

The symbols used in this series of modules are those accepted by the American National Standards Institute (ANSI) and the Institute of Electrical and Electronics Engineers (IEEE).

It should be noted at this point that the following modules are not an attempt to teach you the functions and uses of various electronic components. They are merely an attempt to teach you the basics of reading and interpreting electronic drawing and diagrams.

Information

1. SYMBOLS AND MODIFIERS

The symbols discussed in this and subsequent modules are designed to be used in "single-line" or schematic drawings. Schematic drawings will be discussed in detail in another module.

Symbol modifiers are symbols used in conjunction with basic symbols to tell you more about the component. For example, the basic symbol modifier for adjustability is:

Adjustability

This modifier is used with basic symbols for capacitors and resistors to indicate a special characteristic of that component. There are two other forms of the modifier for adjustability.

Linear

Nonlinear

These further describe the component.

Special properties of a component can also be described with a symbol modifier.

Storage Type

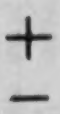
t°

Temperature Dependent

Polarity is indicated as positive or negative and in some cases, both positive and negative are used to show polarity reversal characteristics of components.

Positive

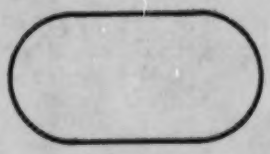
Negative



Positive or Negative

Envelopes for components can be in a variety of shapes and sizes to accommodate the elements of a particular component. A shielded envelope is shown as a dashed line. A split envelope is shown as two halves of a regular envelope.

Regular



Elongated

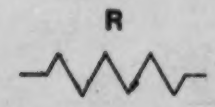
Split

Shielded

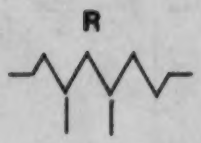
6

2. RESISTORS

Among the basic components used in most electronic circuits is the resistor. The basic symbol is shown below. The "R" denotes resistor.



A modifier symbol for a resistor might look like one of these:



Tapped Resistor

Potentiometer

Rheostat

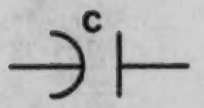
Voltage Sensitive Resistor or "Varistor"

Temperature Sensitive Resistor or "Thermistor"

Notice that the voltage sensitive and temperature sensitive resistors have the added letters "V" and "T" respectively, to their designations.

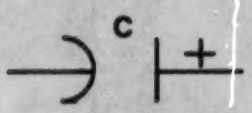
3. CAPACITORS

Because of the wide variety of capacitors available, graphic symbols for capacitors may employ several symbol modifiers to completely describe their special characteristics. The basic symbol for a capacitor is shown on the next page.



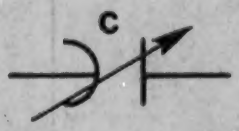
The curved part of this symbol indicates several elements for different capacitors. For example, in a fixed paper or ceramic dielectric capacitor, it shows the outside electrode. In feed-through capacitors it indicates the low-potential element, and in still other capacitors it may indicate something different. The point to remember is that there is a difference and it's position is significant to the circuit.

Electrolytic capacitors are polarized so the symbols show the polarity.

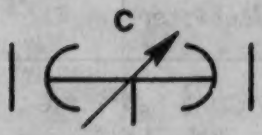


Some of the other common capacitor symbols are:

Shielded



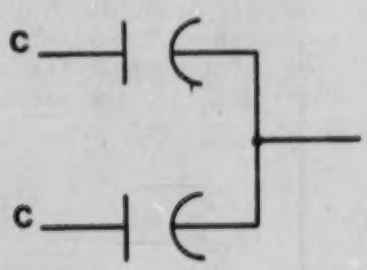
Adjustable



Split-Stator

Feed-Through

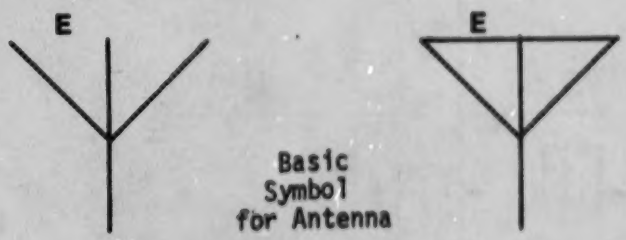
Dual or multiple unit capacitors that have a common positive or negative connection are illustrated below.



4. ANTENNAS

There are several symbols used to represent antennas, depending upon their form. Symbol modifiers or qualifying symbols may be placed next to the basic symbol to indicate special characteristics such as polarity.

The basic symbol is shown in two versions below.



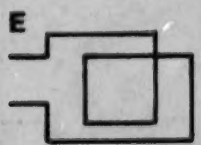
Basic Symbol for Antenna

A few variations of the antenna symbol are shown below. Notice that a very special type of antenna may have a special symbol of its own.

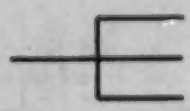
Horizontally Polarized Antenna

Radio Beacon

Dipole Antenna



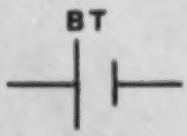
Loop Antenna



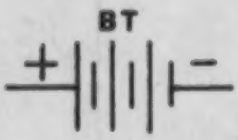
Counterpoise

5. POWER SOURCES

A single cell or "dry" cell is used to make up a battery. Therefore, the symbol for a single cell is repeated to indicate a storage battery. The single cell and multiple cell are shown below. Notice that the multiple cell indicates polarity by using the positive and negative symbol modifiers.



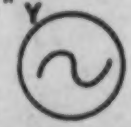
One Cell



Multicell

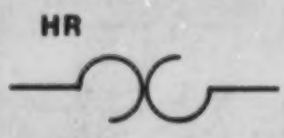
In some cases a multicell may be tapped at several places. The symbol for a multicell with three taps is shown below.

An oscillator or a generalized alternating current power source is shown below. Notice that the letter designation for this component is "Y" not "BT."

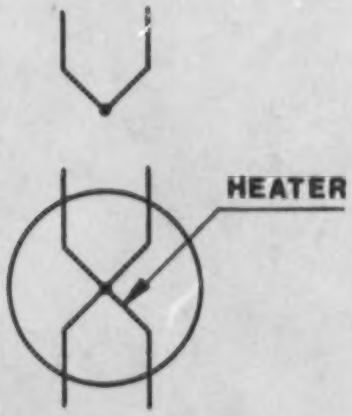


6. THERMAL DEVICES

There are several electronic components that are activated or cause circuit changes do to temperature changes. The symbols vary according to the particular function of the component. The general symbols for a temperature-actuated device or thermal element are shown below. The two three-quarter circles in the symbol to the right represent a bimetallic strip that changes shape with temperature variations.



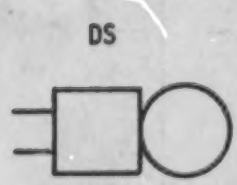
The symbol below shows a very special type of thermal component. The upper portion of the symbol shows a temperature-measuring thermocouple which is used with a thermocouple having an integral heater (shown in the lower part of the symbol). Notice the letter designation "TC."



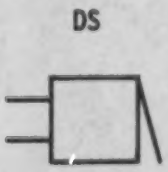
THERMOCOUPLE

7. ACOUSTIC DEVICES

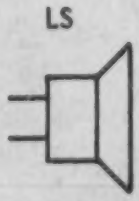
Most of us are familiar with the components called acoustic devices. They provide an audible response to an electric current, such as, the speaker in a radio circuit. Some of the basic symbols are shown below.



BELL

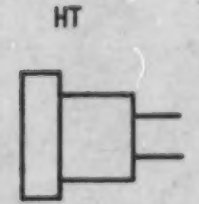


BUZZER

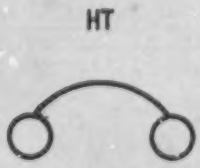


HORN

LOUDSPEAKER



RECEIVER



DOUBLE HEADSET

Self Assessment

Directions: Place the correct name of the component in the space provided at the right of the symbol. Pay particular attention to symbol modifiers. Check your answers with those on the next page.

1.

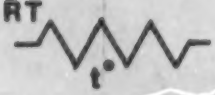
_____

2.

_____

3.

_____

4. 

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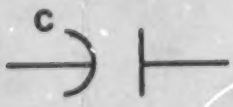
5. 

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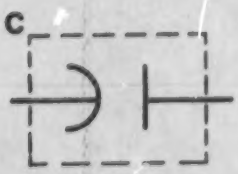
6. 

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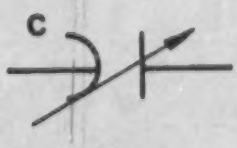
7. 

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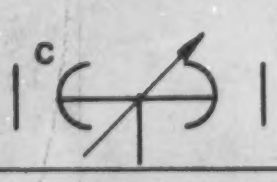
8. 

_____

9.

10.

11.

12.

13.

14.

15.

16.

Answers:

1. Resistor; 2. Reostat or Variable Resistor; 3. Tapped Resistor
4. Temperature Sensitive Resistor or Thermistor; 5. Capacitor;
6. Shielded Capacitor; 7. Adjustable Capacitor; 8. Split-Stator
Capacitor; 9. Antenna; 10. Radio Beacon; 11. Loop Antenna;
12. Multicell or Storage Battery; 13. Oscillator; 14. Thermal
Element; 15. 16.

Study Guide

For Further Information:

IEEE Standard and American National Standard, Graphic Symbols for Electrical and Electronic Diagrams, 1971, Y32.2.

Electrical and Electronics Drawings, Baer, 1973.

Electronic Drafting, Shiers, 1962.

Electronic Drafting Handbook, Rasknodoff, 1971.

ILS Drafting: Electrical/Electronics, article 26.60

Drafting

Circuit Protectors
Composite Assemblies
Contracts, Switches & Relays
Terminals & Connectors

Goal:

The student will be able to identify basic circuit control symbols used on electronic drawings.

Performance Indicators:

Given graphic illustrations of basic circuit control symbols, the student will identify them by the industry name.

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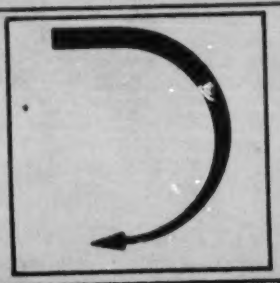
Introduction



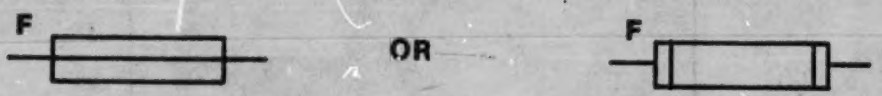
INTRODUCTION:

There are several components found in almost every electrical or electronic circuit that perform basic functions such as switching or diverting current or simply protecting the circuit from overloads. These components may vary in outward appearance from one type to another, so the symbols used to represent them symbolize more closely their functions rather than their appearance.

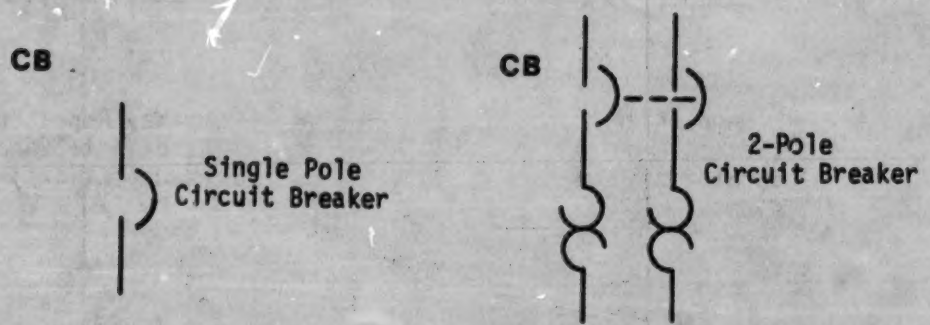
Information

1. CIRCUIT PROTECTORS

Circuit protectors may be fuses that melt during overload conditions or automatic devices, such as circuit breakers or overload relays. Fuses are generally used because of their small size. The general symbol for a fuse is shown below.



Circuit breakers are automatic devices that interrupt current flow during overload conditions. The basic circuit breaker symbols are shown below.



Notice the symbol for a thermal element in the example of a 2-pole circuit breaker. This example also shows a mechanical linkage between the 2 poles of the circuit breaker, with a dashed line.

2. COMPOSITE ASSEMBLIES

Composite assemblies may consist of a number of components connected together mechanically or electrically. The main reason for using composite assemblies is to save space and avoid repetition.

When a rectangular shape is used to represent a circuit element element, some of the following letter designations may be used to help identify the element.

EQ means Equalizer

FL means Filter

FL-BP means Bandpass Filter

PS means Power Supply

RU means Recording Unit

TTY means Teletypewriter

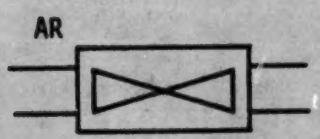
A single circuit element may be represented by a rectangular shape, a triangle, or a square.

Circuit Element

Some simple composite assemblies are shown below.

Amplifier
(Triangle points in direction of flow)

One-Way Repeater
(Used in telephone communications)



Two-Way Repeater

Three Wire or
Three-Way Shifting
Network (Phase Shifter)

3. CONTACTS, SWITCHES, AND RELAYS

There are several types of symbols used in depicting contacts and switches. In most cases, the symbol is fairly easy to understand if you remember the function of the component. Some of the basic contact symbols are shown below. Each will be used as a part of a switching or relay device.

Fixed Contacts

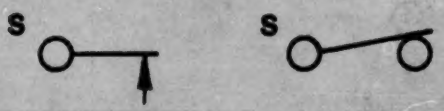
Fixed Switch Contact

Locking Contact

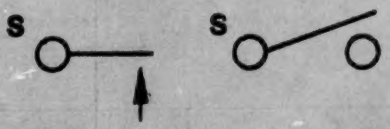
Rotating Contact

Segment Contacts

Basic contact assemblies may vary slightly. The position of the arrow or line segment shows the normal position of the switch (open or closed).



Normally Closed Contacts

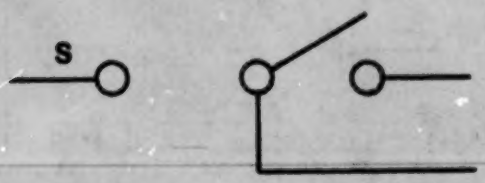


Normally Opened Contacts

A current transfer device is shown below.

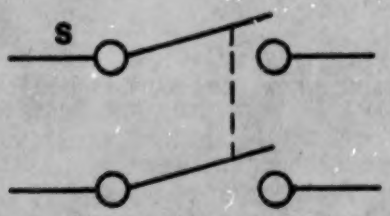
All the examples of switch assemblies shown so far are single-throw or one-direction switches.

A switch that is known as a transfer switch may be capable of movement in more than one direction. For example, a switch for forward-off-reverse type control is called a single-pole, double-throw switch. The reference to "pole" indicates the number of circuits.



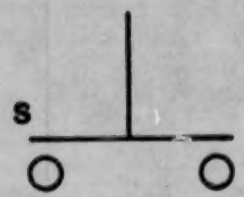
Single-Pole, Double-Throw
(SPDT)

A variation of the switch above is a double-pole, double-throw switch. Notice the symbol for mechanical linkage (dashed line).

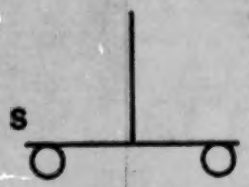


Double-Pole, Double-Throw

Push button type switches are slightly different because of their function in the circuit.

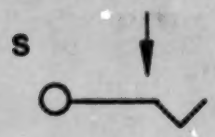


Push Button
(Open)

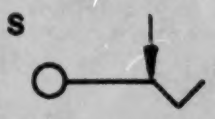


Push Button
(Closed)

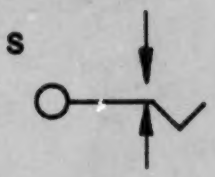
In some cases, it is necessary to "lock" a switch in a desired location. In that case, a symbol modifier is used.



Locking Switch (Open)

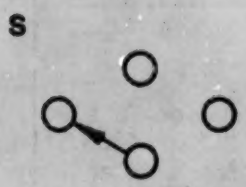


Locking Switch (Closed)

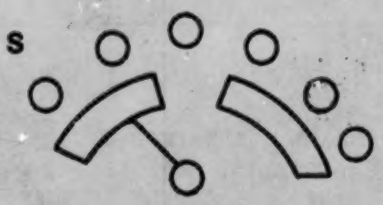


Single-Pole, Double Throw Locking Switch

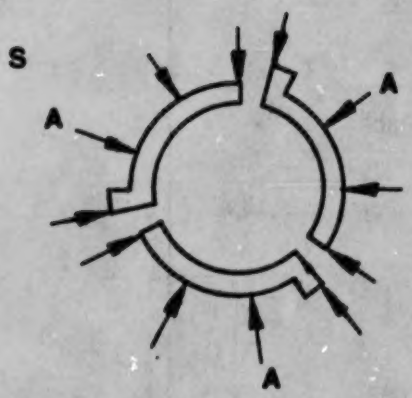
Some of the other types of switching devices are shown below. Pay particular attention to symbol modifiers.



Three Position Switch



Segment Switch (more than one contact is shorted by the moving part of switch)



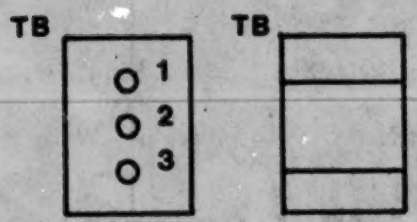
Rotary Switch ("A" shows the corresponding contact for each segment)

Thermostat

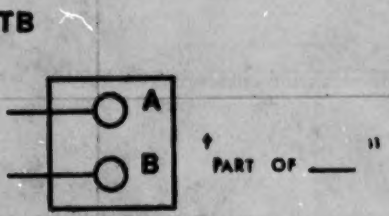
Flasher (Temperature Activated)

4. TERMINALS AND CONNECTORS

On symbols for terminals and terminal boards, a single circle reprsents each separate terminal. Terminal identification is normally governed by convenience, rather than any particular sequencing. When necessary, parts of a terminal board may be separated and identified. The reference designation is used for identification.

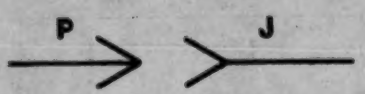


Basic Terminal Board Symbols



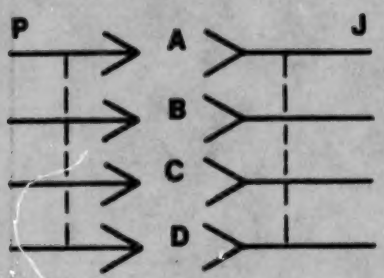
A portion of a larger terminal board

Each of the various types of connectors used in electronic equipment has its own characteristics. Therefore, the symbols for connectors vary greatly, with the function and type of connector. However, most of the symbols will identify two parts of the connector as the "plug" and the "jack."

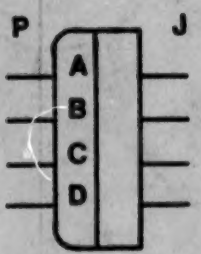


Basic Symbols for Plug and Jack

Some of the connector assemblies are shown below.

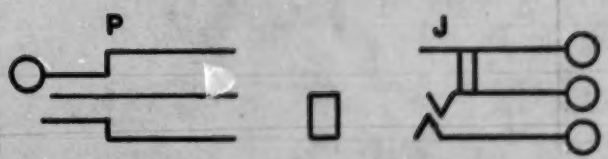


Multiconductor



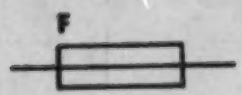
Plug and Receptacle

Three-Conductor
Plug and Jack,
with Locking Feature
on Jack.

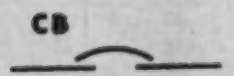


Self Assessment

Directions: Place the proper name of the component by the symbol. Check your work with the answers on the next page.

1. 

_____

2. 

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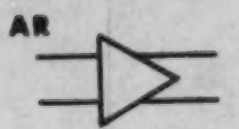
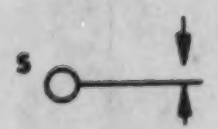
3. 

_____

4.
_____

5.
_____

6. 

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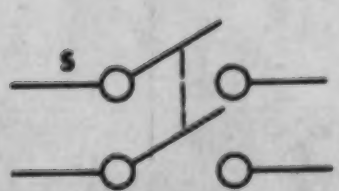
7. 

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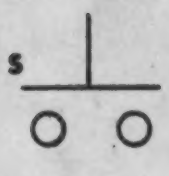
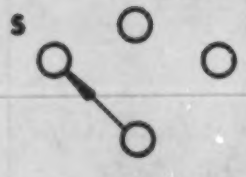
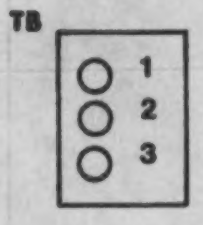
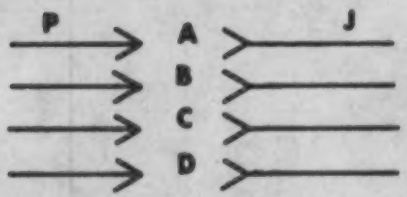
8. 

9. 

10.

11.

12. 

13. 

Answers to Self-Test:

1. Fuse
2. Circuit Breaker
3. Composite Assembly or Amplifier
4. Locking Contact
5. Segment Contact
6. Current Transfer Device
7. Double-Pole, Double-Throw Switch
8. Push Button Switch
9. Three-Way Switch
10. Thermostat
11. Flasher
12. Terminal Board
13. Multiconductor Connector

Study Guide

For Further Information:

IEEE Standard and American National Standard, Graphic Symbols for Electrical and Electronic Drawings, 1971, ANSI Y32.2.

Electrical and Electronics Drawings, Baer, 1973.

Electronic Drafting, Shiers, 1962.

Electronic Drafting Handbook, Raskhodoff, 1971.

ILS Drafting: Electrical/Electronics, article 26.60

INSTRUCTIONAL LEARNING SYSTEMS

Drafting

Element Symbols

Diode, Troide, Pentode

Modified Symbols

Special Symbols

Electrode Numbering

Goal:

The student will know the difference between various types of symbols and modified symbols for electron tubes.

Performance Indicators:

Given graphic illustrations of various electron tube symbols, the student will provide the correct name for the symbol.

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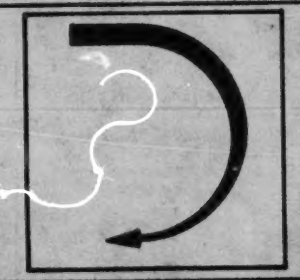
Introduction



INTRODUCTION:

Electron tubes are made up of various elements which have different functions in the circuit. Therefore, most symbols for electron tubes will have a few basic elements or symbols. Each tube will, in most cases, consist of an envelope, a cathode or emitter, and an anode. Other elements that may appear in the envelope are grids, filaments, taps, or symbols such as the one for gas-filled.

Information

1. ELEMENT SYMBOLS

Because of the variety of configurations for electron tubes, they may use any combination of a few basic elements to depict that tube in symbol form. Some of the basic elements used in electron tubes are shown below.

Cathodes:

Plain Filament

Indirectly Heated

Cold

Photo Emissive

Controlling Electrodes:

Grid

Deflector

Collecting Electrodes:

Anode

Target

Collecting and Emitting Electrodes:

Dynode

Anode - Photocathode

Anode - Cold Cathode

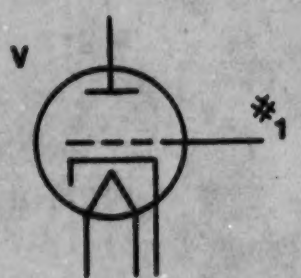
2. DIODES, TRIODES, PENTODES

The simplest type of electron tube is called a diode, which consists of an indirectly-heated cathode that emits electrons. When the anode or plate is made positive in respect to the cathode, the electrons flow toward the plate until it is made negative. Thus, the diode acts as a valve (rectifier). Shown below, are two types of basic diodes.

Half-Wave Rectifier (Diode)

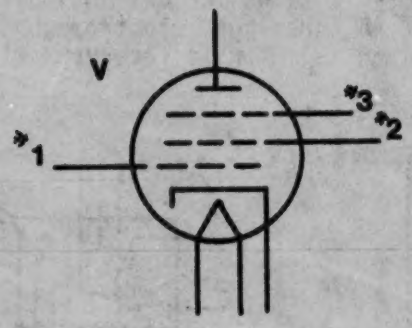
Full-Wave Rectifier (Diode)

By inserting another element into the basic diode, between the cathode and the "plate," it is possible to control the electron flow. The electron tube is then called a triode. The additional element is a grid. The grid is usually identified by a number, as shown in the example below.



Triode

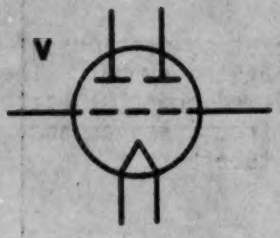
By adding two more grids, called screen and suppressor grids, the basic electron tube is now called a pentode. The additional grids are numbered 2 and 3, respectively.



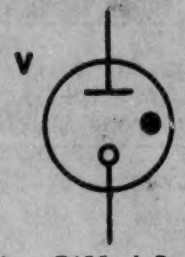
Pentode

3. MODIFIED SYMBOLS

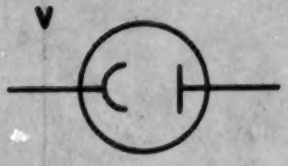
The basic electron tube symbols can be modified by adding one or more symbol modifiers. A few basic examples are shown below.



Twin Triode



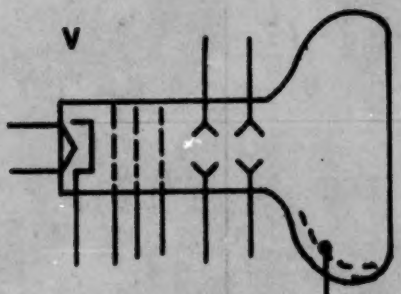
Gas-Filled Rectifier
(No Heater Symbol)



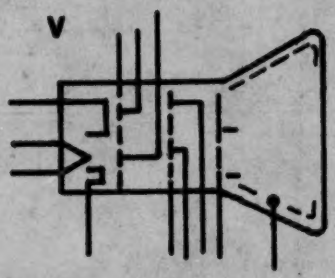
Phototube
(Or Photoelectric
Electron Tube)

4. SPECIAL SYMBOLS

The electron tube envelope may take different shapes to accommodate all the various elements necessary for a particular function. One well-known tube that fits this description is the cathode-ray tube, which contains an electron gun assembly, a means for deflection, and a fluorescent screen. A three-gun, electromagnetic deflection "CRT" is the type used in color TV receivers.



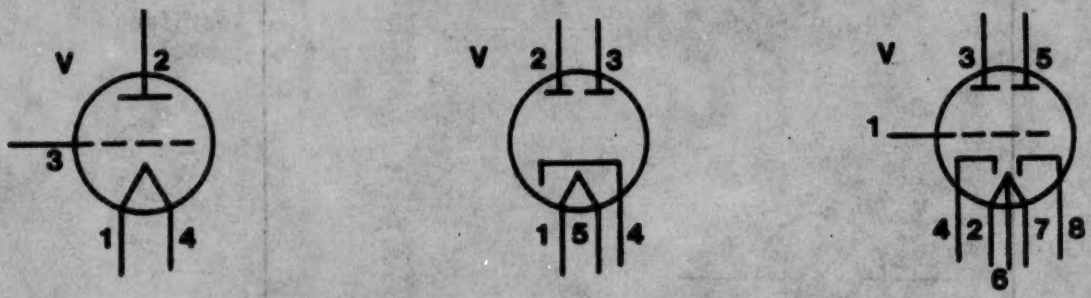
Single-Gun CRT
(Cathode-Ray Tube)



Three-Gun CRT

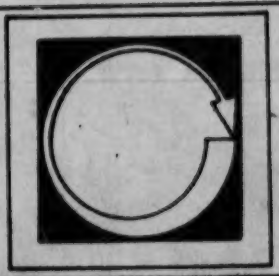
5. ELECTRODE NUMBERING

It is customary to identify the socket connections of an electron tube around the perimeter of the symbol. The numbers correspond to the pin numbers as viewed from the bottom of the tube. They are numbered clockwise from a key or some other reference point as viewed from the tube bottom.



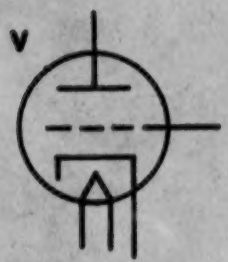
Examples of Electrode Numbering.

Self Assessment

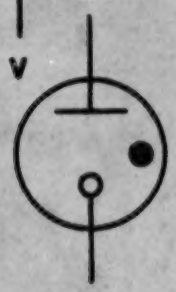


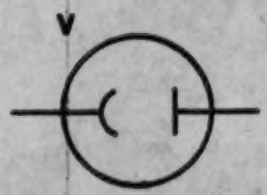
Directions: As completely as psssible, name the following symbols for electron tubes in the spaces provided.

1.

2. 

3.

4. 

5. 

9. _____

_____

Answers:

1. Diode or Half-Wave Rectifier; 2. Triode; 3. Twin Triode; 4. Gas-Filled Rectifier; 5. Phototube or Photoelectric Electron Tube; 6. Single-Gun Cathode Ray Tube.

Study Guide

For Further Information:

IEEE Standard and American National Standard, Graphic Symbols for Electrical and Electronic Drawings, 1971, ANSI Y32.2.

Electrical and Electronics Drawings, Baer, 1973.

Electronic Drafting, Shiers, 1962.

Electronic Drafting Handbook, Raskhodoff, 1971.

ILS Drafting: Electrical/Electronics, article 26.60

Drafting

Basic Symbols

Transformer Symbols

Special Transformer Symbols

Goal:

The student will be able to identify the various components that use one or more windings for desired current characteristics in an electronic or electrical diagram.

Performance Indicators:

Given graphic illustrations of various electrical symbols, the student will identify the symbol by its proper name.

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Introduction

INTRODUCTION:

A simple definition for an electric motor would be: one or more windings of wire about an armature or rod which is able to rotate.

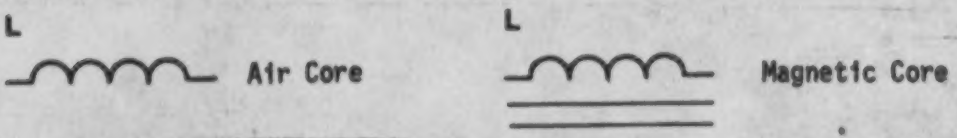
Although electric motors are much more complex, the example definition illustrates one of the basic functions of an electrical winding.

Windings are used in various components to produce specific current flows and to introduce a desired magnetic field. Another example of the application of a winding is in the simple transformer.

Information

1. BASIC SYMBOLS

The basic symbol for a winding consists of at least two half-circle loops. The exact symbol may vary slightly, depending on the origin of the diagram or a particular firm's drafting practice. The air core and magnetic core windings are shown below. The two additional parallel lines indicate the magnetic core.



Windings are often referred to as inductors. A few basic modified inductors are shown below.

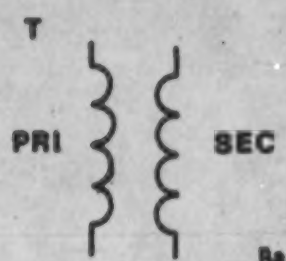
Tapped Inductor

Adjustable Inductor

Continuously-Adjustable Inductor

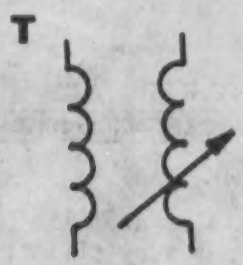
2. BASIC TRANSFORMERS

The transformer consists of two or more independent windings coupled by a common core. Transformers that operate at high frequencies normally are only air core transformers, while those operating at low frequencies are magnetic core. The addition of the labels "PRI" and "SEC" are not part of the transformer symbol but may be included to help identify input side and output side of a transformer.

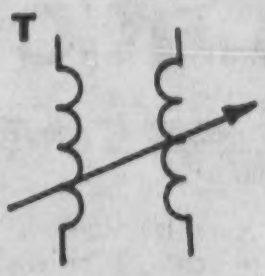


Basic Transformer Symbol

Two modified symbols that may be confused are shown below. Careful examination of the symbol is important so that an error in "reading" does not occur.



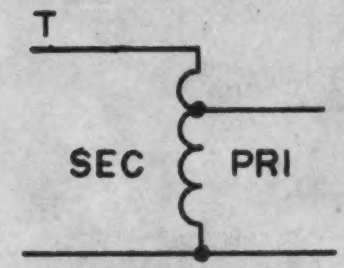
Transformer
w/an Adjustable
Inductor Winding



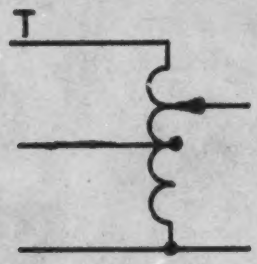
Transformer
w/Variable Coupling
Between the Windings

3. SPECIAL TRANSFORMER SYMBOLS

The basic transformer symbol configuration can be modified or rearranged to indicate special types of transformers. An auto-transformer has a single winding with a tap. Auto-transformers can be adjustable and a modified symbol is used to depict that type.

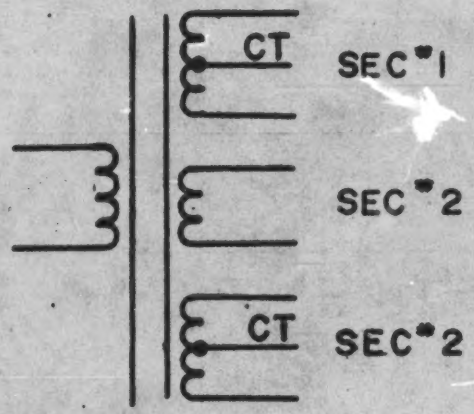


Auto-Transformer



Adjustable Auto-Transformer

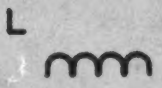
Another special transformer symbol is the one used for a multiple-winding transformer. The example below shows a multiple-winding transformer with two taps. Notice that the taps are designated by the letters "CT" and each of the secondary windings are numbered.



Multiple-Winding Transformer with Two Taps

Self Assessment

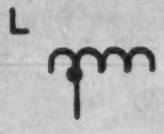
Directions: Fill in the proper name for the symbol shown in the space provided. Check your answers with those on the next page.

1. 

_____

2.

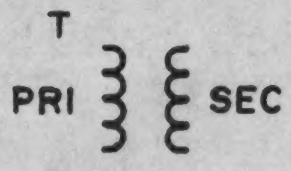
_____

3. 

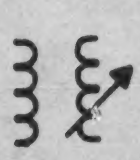
_____

4.

_____

5. 

_____

6. 

_____
_____

7.

Answers to Self-Test:

1. Air Core Winding; 2. Magnetic Core Winding; 3. Tapped Inductor; 4. Adjustable Inductor; 5. Transformer; 6. Transformer with an Adjustable Inductor Winding; 7. Auto-Transformer.

Study Guide

For Further Information:

IEEE Standard and American National Standard, Graphic Symbols for Electrical and Electronic Diagrams, 1971, Y32.2.

Electrical and Electronics Drawings, Baer, 1973.

Electronic Drafting, Shiers, 1962.

Electronic Drafting Handbook, Raskhodoff, 1971.

ILS Drafting: Electrical/Electronics, article 26.60

Drafting

Basic Semiconductor Elements

Symbol Modifies

Two-Terminal Semiconductor

Three or more Terminal Semiconductor

Element Numbers

Hybird Assemblies

Goal:

The student will be able to identify symbols of a variety of semiconductor devices.

Performance Indicators:

Given graphic illustrations of a variety of semiconductor symbols, the student will identify them by their proper name.

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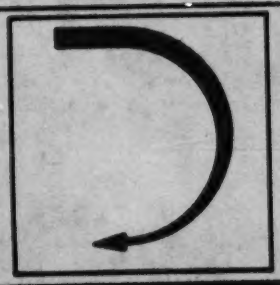
Introduction



INTRODUCTION:

A fairly new family of electronic components, called semiconductors, has emerged in the last 20 years. Semiconductors in the form of transistors have replaced most of the older electron tubes in electronic circuits. The semiconductors are quite small and don't give off heat, unlike electron tubes. In the last few years, the semiconductor has become the primary component in integrated circuits, which have brought about some of the recent changes in computer circuits, small calculator circuits, and other specialized electronic equipment.

Information

1. BASIC TRANSISTOR ELEMENTS

Silicon and germanium are the two materials most commonly used for semiconductor devices. Adding controlled impurities produces semiconductor material of the "P" or "N" type. A "PN" junction of these materials will act as a diode or rectifier.

A transformer is a solid-state device consisting of a sandwich of NPN or PNP sections. In a junction-type transistor, the three sections are composed of an emitter, a center section or base, and a collector, which are the equivalent of the elements of a triode-type electron tube.

The basic elements of a transistor may include the base or bar, a base with two ohmic connectors, a rectifying junction (P region on N region), and a rectifying junction (N region on P region). At this point, don't attempt to understand the internal functioning of the transistors. Try to identify the different symbols and place a label on that particular configuration. A deeper study of electronic theory is needed to fully comprehend the workings of these transistors.

Some of the basic symbol elements are shown below.

Base or Bar

Base with two ohmic connectors

Rectifying junction P Region on N Region

Rectifying Junction N Region on P Region

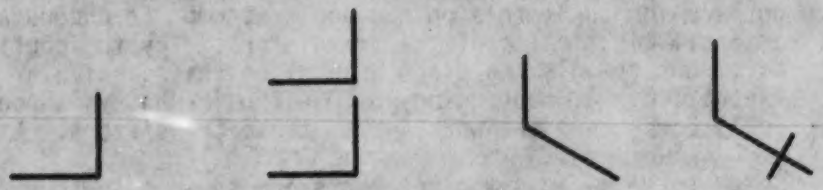
2. SYMBOL MODIFIERS

To help identify special characteristics of the basic semiconductor components, symbol modifiers are used. These modifiers are unique to semiconductors.

P-Emitter N-Emitter Collector

An element of the semiconductor, which acts like a cathode in a electron tube, is called an emitter. The equivalent element to an anode or target in an electron tube is called a collector. These elements are shown above. Notice that the arrow points toward the base of the P-emitter and away from the base in the N-emitter.

Gates or control elements are used much like grids in the electron tube. A few examples are shown below.



Insulated Single Gate | Insulated Multiple Gate | Con rol Gate | Turn-Off Gate

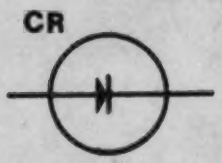
Special property symbols are used to further identify a semiconductor. They are placed within the envelope or next to the main symbol.

Breakdown or Zener | Backward | Tunneling | Capacitive

3. TWO-TERMINAL SEMICONDUCTORS

Semiconductors can be divided into two basic groups. They are two-terminal and three or more terminal semiconductors. There are a variety of two-terminal devices and the symbols are simply modifications of the basic symbol. These modifications indicate the special properties that each device has.

The basic symbol for a semiconductor is shown below in the form of a rectifier diode.



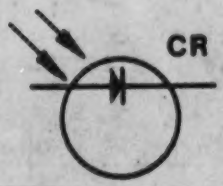
The envelope may be omitted if not confusing.

Rectifier Diode

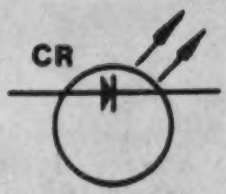
Some of the modified symbols are:

Capacitive Diode or Varactor

Temperature Dependent Diode



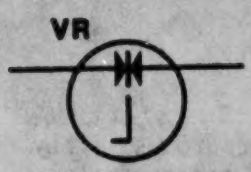
Photosensitive Diode (Photo Diode)



Photoemissive Diode

Storage Diode

Breakdown Diode (Voltage Control)



Bidirectional Diode

Tunnel Diode

PN PN Switch

Photo-Activated Switch

----- DIODE SWITCHES -----

Notice that, for all the previous symbols, the distinguishing feature is one or more modifier added to the basic symbol. Therefore, a thorough understanding of these modifier's will enable you to distinguish one semiconductor device from another.

4. THREE OR MORE TERMINAL SEMICONDUCTORS

The three or more terminal devices are simply build-ups of the two-terminal devices. The basic transistor falls in this grouping. The symbols below show the two basic transistor symbols. Notice the designation letter is not "CR," but "Q."

PNP-Type Transistor

NPN-Type Transistor

Notice the directions of the arrows follow the basic rule for P and N emitters.

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The symbol below shows a single junction device with a double-base diode called a unijunction.

Unijunction

Field-Effect Transistors or FET's take a variety of configurations. Some of them are shown below.

3 Terminal

Insulated Gate

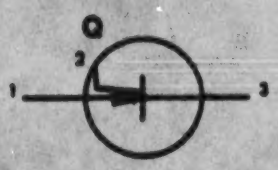
4 Terminal

4 Terminal, 2 Gates

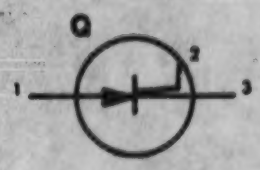
Notice that the direction of arrow in relationship to the base indicates these are N-channel or N-type junctions. P-type would have the arrow reversed.

The letter designations on the field-effect transistor symbols indicate the connector's identification. They are not normally part of the symbol, but may be used for clarification. Their meanings are:

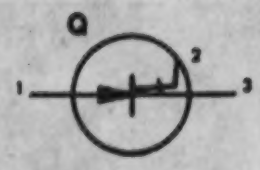
Semiconductor Controlled Rectifiers are, again, simply modified two-terminal semiconductors.



N-Type Gate



P-Type Gate



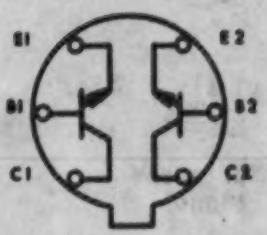
P-Type Gate Switch

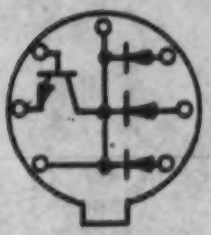
5. ELEMENT NUMBERS

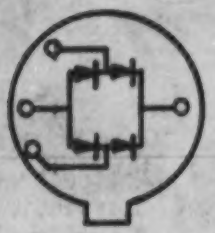
Transistor element numbers are assigned reading clockwise, as viewed from the bottom of the transistor. They are normally #1 for the emitter, #2 for the base, and #3 for the collector. Examples are shown on the previous page.

6. HYBRID ASSEMBLIES

Microminiature circuits of today demand components that are more compact and sometimes more complex. A response to this demand was the multiple diode-and-transistor assembly within one transistor envelope. They are designated by "TO-5" or "TO-18." These assemblies have their own circuit with connections to the outside from each semiconductor or interconnection of some of the semiconductors. Some of the circuits are shown below.

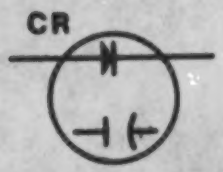






Self Assessment

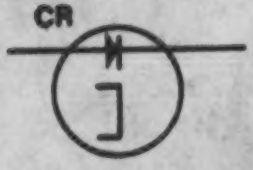
Directions: Identify the following two-terminal semiconductor devices in the spaces provided next to the symbol.

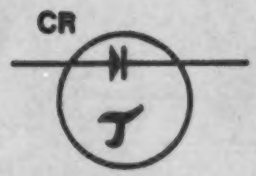
1. 

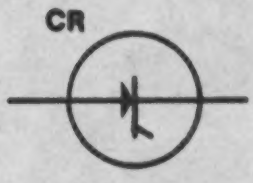
2.

3.

4.

5. 

6. 

7. 

Directions: Place the correct name of the three or more terminal semiconductor in the spaces provided.

8.

9.

10.

11.

12.

Answers:

1. Capacitive diode or varactor; 2. Temperature dependent diode; 3. Breakdown diode; 4. Photosensitive diode; 5. Tunnel diode; 6. Storage diode; 7. PNPN switch or diode switch; 8. PNP transistor; 9. NPN transistor; 10. Double-base diode or unijuction; 11. 4-terminal F.E.T.; 12. N-type semiconductor controlled rectifier.

Study Guide

For Further Information:

IEEE Standard and American National Standard, Graphic Symbols for Electrical and Electronic Diagrams, 1971, ANSI Y32.2.

Electrical and Electronics Drawings, Baer, 1973.

Electronic Drafting, Shiers, 1962.

Electronic Drafting Handbook, Raskhodoff, 1971.

ILS Drafting: Electrical/Electronics, article 26.60

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Drafting

Lamps & Signals

Mechanical Functions

Readout Device

Rotary Machinery

Goal:

The student will be able to identify symbols that indicate lamps, meters, rotary machinery and mechanical functions.

Performance Indicators:

Given graphic illustrations of electrical symbols, the student will identify each symbol by its proper name.

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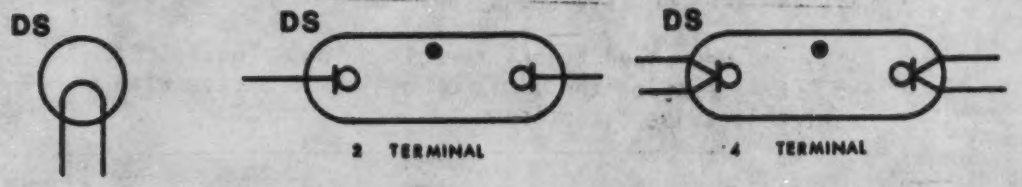
Information

1. LAMPS AND SIGNALS

There are two basic types of lamps (fluorescent and incandescent). A fluorescent lamp may be one of two types (two-terminal or four-terminal).



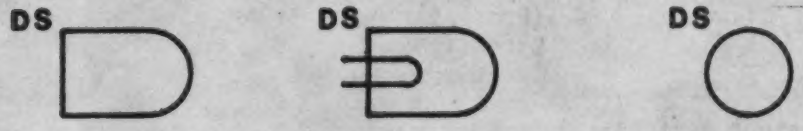
Incandescent Fluorescent

Notice the gas-filled symbol in the fluorescent lamps.

Among the visual signaling devices are those for indicators, pilot lights and signaling lamps. To avoid confusion with meter or relay symbols, the suffix "L" or "IL" should be added to the color designation letters. These letters are:

A = amber	B = blue	C = clear	R = red
NE = neon	O = orange	P = purple	
W = white	Y = yellow	G = green	

The symbols are:



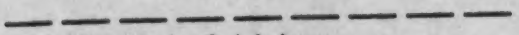
With color designations they are:

A jeweled signal light symbol is:

2. MECHANICAL FUNCTIONS

Since it is sometimes necessary to identify mechanical details such as linkage or motion on circuit diagrams, a group of symbols have been assigned for this purpose.

The symbol for mechanical connections or linkage is just a dashed line between elements of the components.



Mechanical Linkage

Linkages are normally shown on switches.

Motion is described by the symbols below. The letters "CW" and "CCW" describe the limit of motion in a clockwise or counterclockwise direction.

Clockwise Counterclockwise Both Ways

Adjustable Resistor (Reostat) in Clockwise Direction

3. READOUT DEVICES

A wide range of meters and electromagnetically-operated counters are classified as readout devices. The function of the meter is not described by a different symbol but by using a common symbol and a letter designation to explain its function.

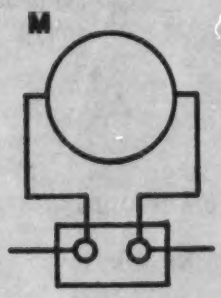
The basic meter symbol is a circle with the designation letter placed inside.

DESIGNATION LETTER

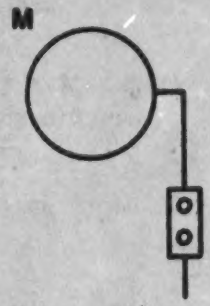
Meter function designations are described by the following letters:

A = ammeter	OHM = ohmmeter
AH = ampere-hour	PF = power factor
DB = decibel meter	V = voltmeter
F = frequency meter	VA = voltammeter
UA = microammeter	W = watt meter
MA = milliammeter	WA = watt-hour meter

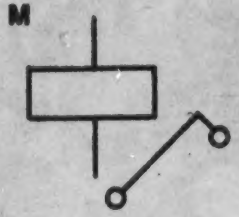
The basic meter symbol may be modified to show a special component that is part of the meter.



Meter with a Shunt Resistor



Meter with a Multiplier



Electromechanically-operated counter

4. ROTARY MACHINERY

Rotary machinery consists of such devices as motors, generators, and synchros. The basic symbol for rotary machinery is a circle with a letter designation.

Basic Symbol

Generator Direct Current

Generator Alternating Current

Motor D.C.

Motor A.C.

Notice that the designation letters are underlined if the device is "D.C." and a "Hertz" symbol appears under them if the device is "A.C."

Modified symbols are shown below:

1-Phase

2-Phase

3-Phase
Wye

Motors with Winding connections shown

Synchros with either 60 hertz or 400 hertz power inputs are shown below.

Control Transformer
Receiver Transmitter

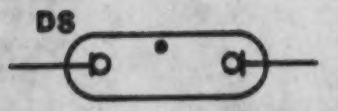
Differential Receiver
Differential Transmitter

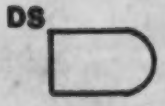
61

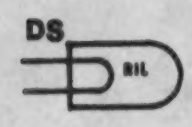
Self Assessment

Directions: Name the symbols shown in the spaces provided.

1.

2. 

3. 

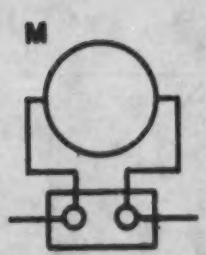
4. 

5.

6.

7. _ _ _ _

8.

9. 

10.

11.

12.

Answers to Self-Test:

1. Incandescent Lamp; 2. 2-Terminal Fluorescent Lamp; 3. Pilot Lamp; 4. Red Pilot Lamp or Red Signal Lamp; 5. Jeweled Signal Lamp; 6. Clockwise Rotation; 7. Mechanical Linkage; 8. Ammeter; 9. Meter with Shunt Receiver; 10. D.C. Generator; 11. A.C. Meter; 12. 3-Phase Wye Motor.

Study Guide

For Further Information:

IEEE Standard and American National Standard, Graphic Symbols for Electrical and Electronic Diagrams, 1971, ANSI Y32.2.

Electrical and Electronics Drawings, Baer, 1973.

Electronic Drafting, Shiers, 1962.

Electronic Drafting Handbook, Raskhodoff, 1971.

ILS Drafting; Electrical/Electronics, article 26.60

Drafting

Basic Composition

Component Identification

Transistor & Electron Tube Stages

Filter & Tuned Circuits

Semiconductor Circuits

Goal:

The student will be able to identify the components and related circuitry of schematic diagrams.

Performance Indicators:

1. Given a schematic of an amplifier circuit showing various symbols, the student will identify the symbols by their proper name.
2. Given a series of uncompleted statements and electrical terms, the student will select the proper term to make each statement a true statement.

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Introduction

INTRODUCTION:

Schematic diagrams are used by technicians and engineers to describe the basic circuit theory and connections of an electronic circuit. The symbols you have studied up to this point will help you read and understand the schematic diagram.

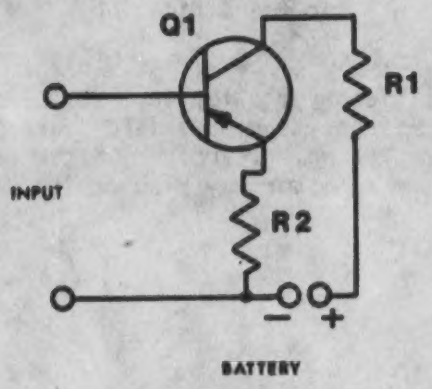
Information

1. BASIC COMPOSITION

Most schematic diagrams have definite sections or groups of components that are related to each other. The easiest way to "read" schematic diagrams is to break down the diagram into small groups and define the function of each group or section. The remaining circuit is then merely an interconnection of these groups.

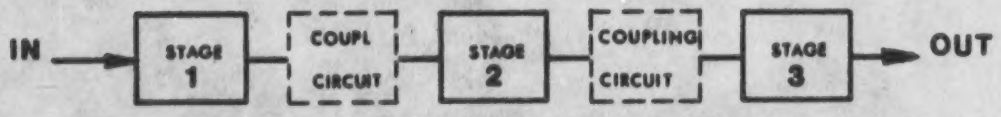
All schematic diagrams are compositions of a few basic elements: graphic symbols, stages, signal and power flow, component identification, and operating controls.

Most schematic diagrams are drawn in stages, with each stage centered around an electron tube or transistor. A basic circuit for a transistor stage is shown below.



Basic Transistor Stage

Each of the individual stages are connected in the circuit with a coupling circuit. A simplified circuit arrangement is shown below. Notice the position of the coupling circuits.

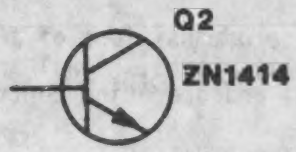


Simplified Drawing of Multiple Stage Circuit

2. COMPONENT IDENTIFICATION

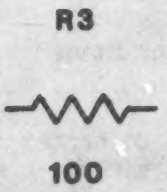
Each major component in a schematic diagram has a specific identification. A combination of letter and numbers will identify the component type, state its position in the circuit and may give further identification numbers.

Transistors may be identified by the letter "Q," followed by a number that states the transistors position in the circuit. Further identification of the transistor may be shown by a second line of numbers such as "2N1414." The "2N" identifies the component (in this case, a transistor). The remaining numbers are identifying numbers for the special characteristics of that transistor.



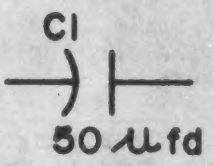
Transistor Identification

Resistors are identified by the letter "R," followed by a number that states its position. Resistors are generally classified by an ohm rating. Therefore, a number indicating the ohm rating of the resistor may also be included by the symbol.



Resistor Identification

Capacitors are identified by the letter "C," followed by a number for indexing or position in the circuit. Capacitors are classified by their farad (fd) or micro farad (fd) rating. Therefore, the capacitance rating may also be included by the symbol.

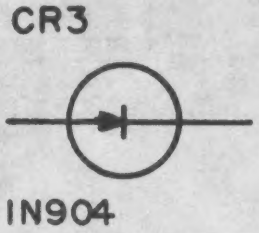


Capacitor Identification

Diodes are identified by the letter "D" followed by an index number. Like transistors they may also be identified by a group of numbers and letters, such as "1N914." The "1N" identifies the component as a diode or rectifier. The "914" is a special characteristic identification for that component.

Rectifier diodes are similar to diodes except they are identified by the letters "CR" followed by an index number.

Diode
Identification



Rectifier Diode
Identification

Some of the other component identification designations:

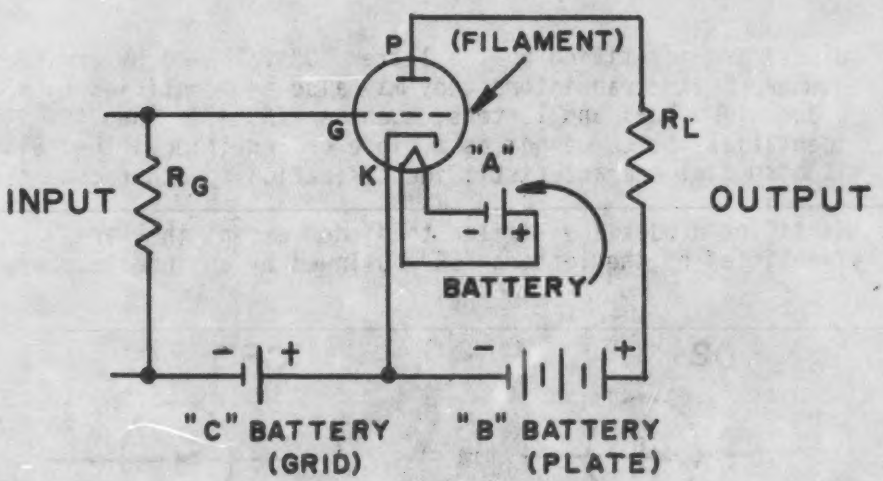
A = Antenna
BT = Battery
CB = Circuit Breaker
F = Fuse
HR = Heater
L = Inductor
DS = Lamp
U = Microcircuit
MK = Microphone
B = Motor
Y = Oscillator
K = Relay
S = Switch
TB = Terminal Board

3. TRANSISTOR AND ELECTRON TUBE STAGES

The basic stages are complete mini-circuits that provide the necessary operating voltages for the transistors and electron tubes along with coupling elements, filtering means, and so forth.

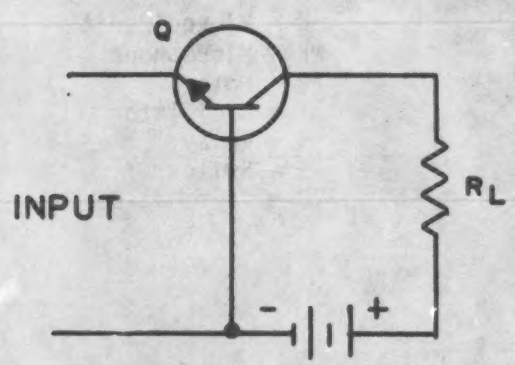
The basic electron tube stage circuit consists of the filament or "A" supply circuit, the plate or "B" supply circuit, and the grid or "C" supply circuit.

In the example below, "R_G" represents the grid resistor and "R_L" represents the plate load resistor.

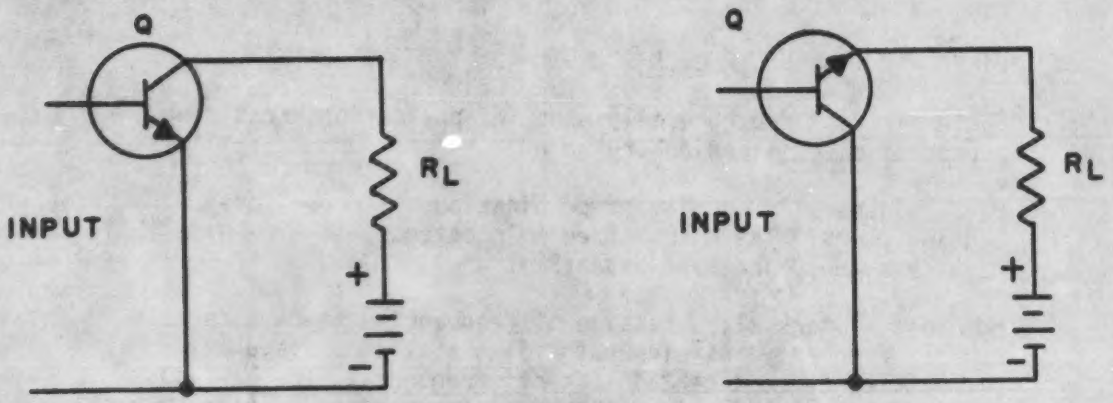


A Basic Electron Tube Stage Circuit

The basic transistor stage circuits can be divided into two types (PNP and NPN). The examples below are for NPN-type circuits. PNP-type circuits will be slightly different.



Basic Transistor Stage Circuit with a Common Base (NPN-Type)



Common Emitter

Common Collector

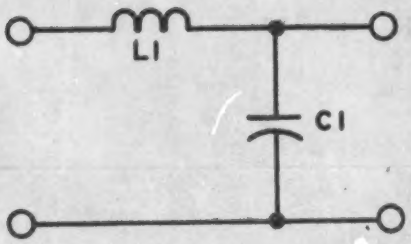
Transistor Stage Circuits

4. FILTER AND TUNED CIRCUITS

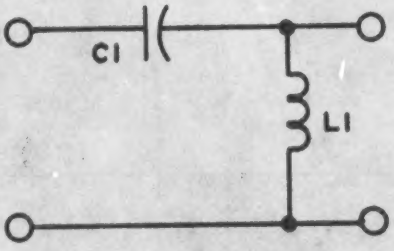
These circuits are generally used in applications requiring frequency discrimination or tuning.

Filters generally consist of combinations of capacitors and inductors. There are three main categories: low-pass (LP), high-pass (HP), and band-pass (BP).

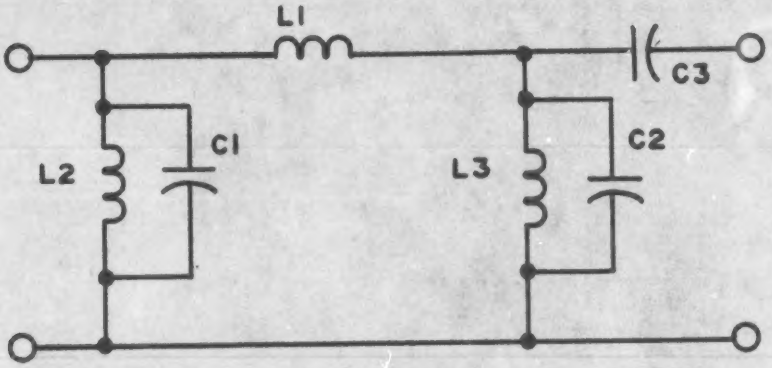
Low-pass filters allow passage of frequencies below a certain cut-off frequency and high-pass filters allow passage of frequencies above a certain cut-off frequency. The band-pass filter allows only a certain band of frequencies to pass.



Low-Pass Filter



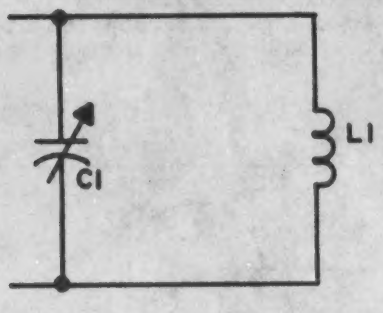
High-Pass Filter



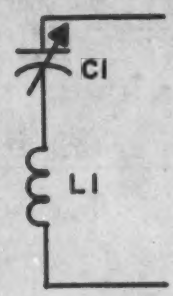
Band-Pass Filter

Tuning circuits are used to select a resonant frequency by varying either the inductance of capacitance.

Tuning circuits, therefore, have an inductance connected in parallel or series with a tuning capacitor.



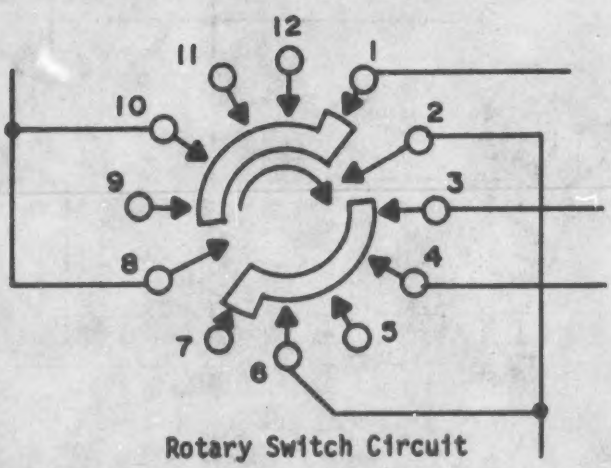
Tuning Circuit
(Parallel)



Tuning Circuit
(Series)

5. SWITCH CIRCUITS

Switches and their circuitry can become very complex. However, the basic components and contacts are quite simple. Even very complicated switching circuits can be easily "read," if you can identify the basic configurations. Rotary switches are often used in electronic equipment for voltage control or circuit switching. An example of a rotary switch is shown below. Each contact is numbered. A table of circuits and corresponding switch contacts may accompany a schematic which has several of these switching circuits.

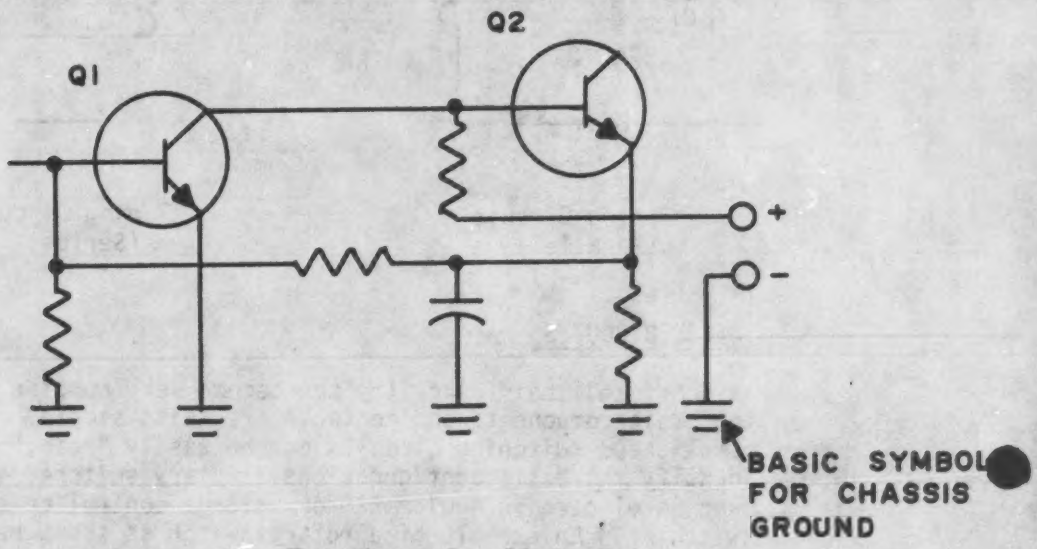


Rotary Switch Circuit

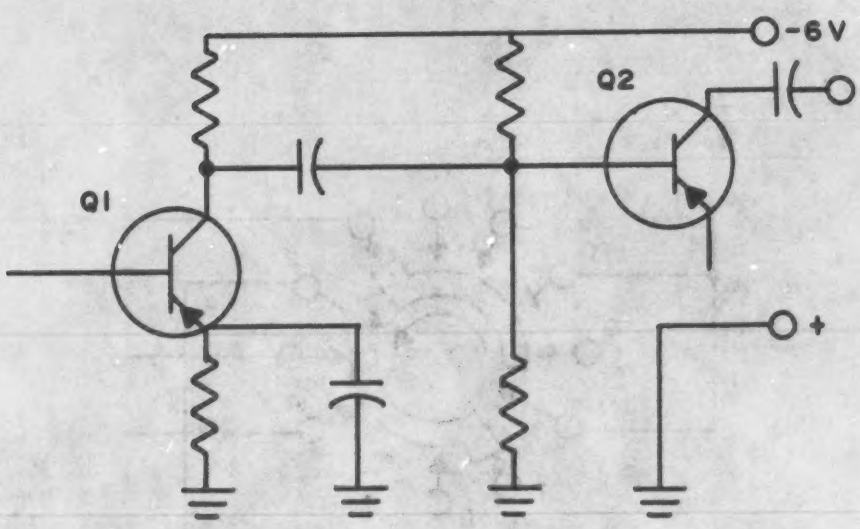
6. SEMICONDUCTOR CIRCUITS

The least expensive type of transistor stage coupling is called the direct-type. It requires a minimum number of components. There are two other common types of couplings used with transistors. The resistance-capacitance type of coupling uses a special resistor and a bypass capacitor. The third type of coupling is a transformer type.

Examples of each are shown below.



Direct-Type Transistor Coupling



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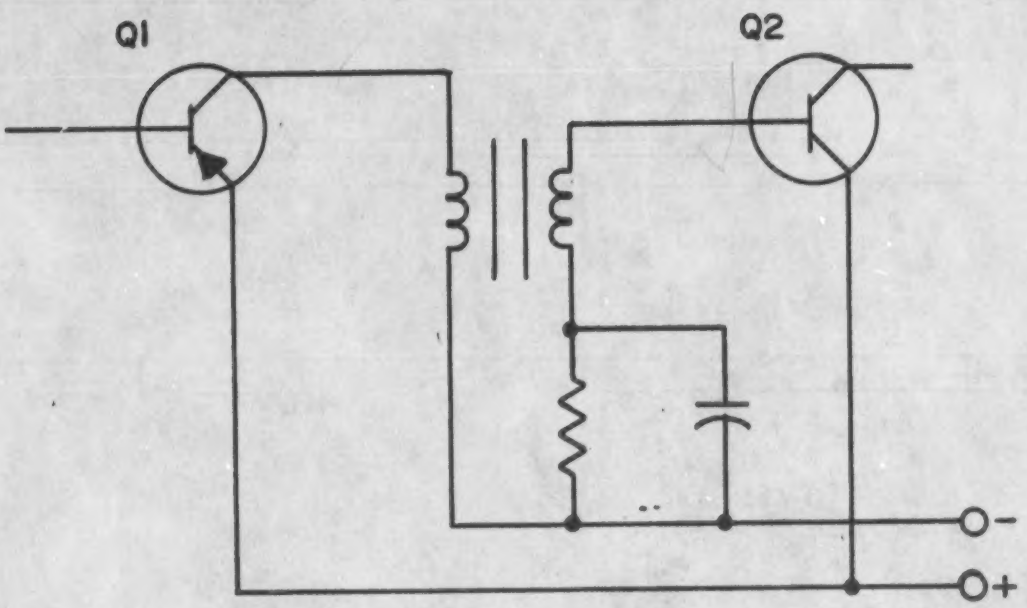
Resistance-Capacitance-Type Transistor Coupling



Transformer-Type Transistor Coupling

Self Assessment

Directions: Complete the following multiple choice questions.

1. Most schematic diagrams are drawn in stages with each stage centered around an electron tube or _____.
(Capacitor, Resistor, Diode, Transistor)

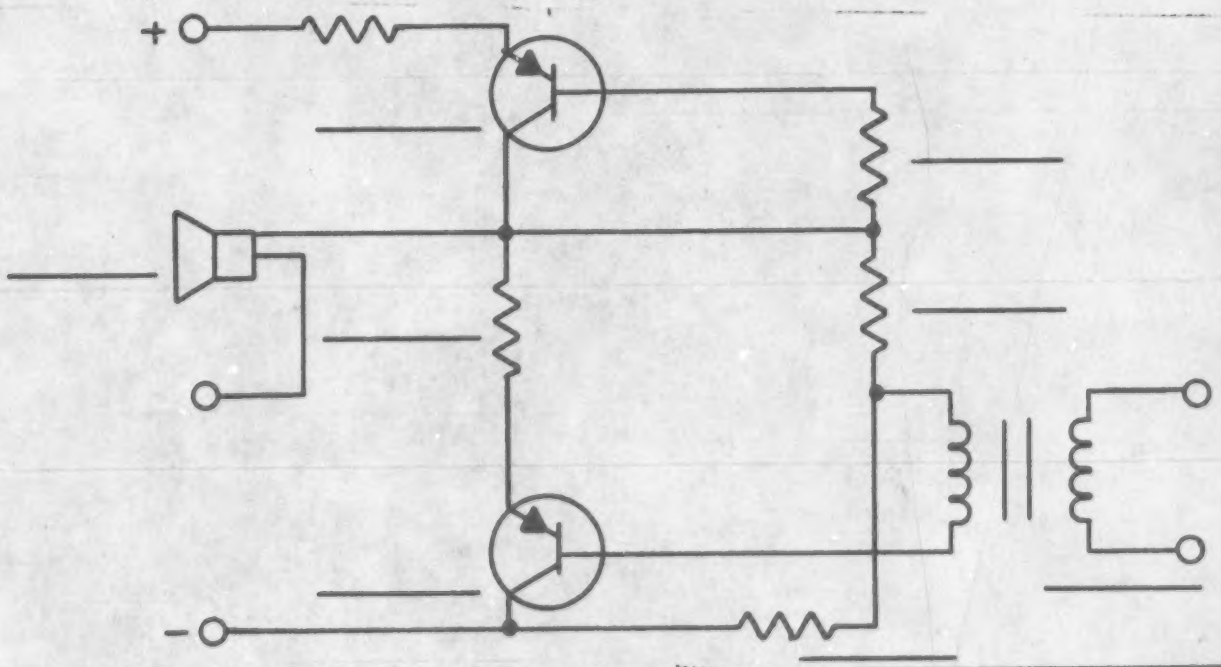
2. _____ connect each of the individual stages in a schematic diagram. (Switches, Transistor, Coupling Circuits, Stage Circuits)

3. "Q" is the identification letter for a _____.
(Capacitor, Diode, Switch, Transistor)

4. "R" is the identification letter for a _____.
(Resistor, Capacitor, Recorder, Diode)

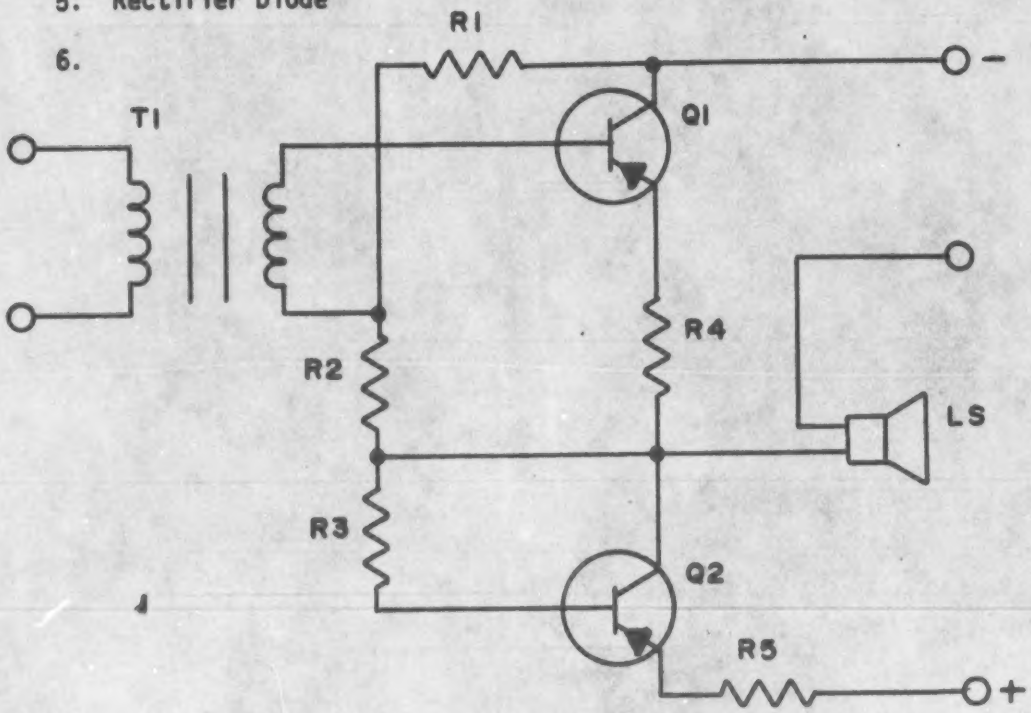
5. "CR" are the identification letters for a _____.
(Diode, Transistor, Rheostat, Rectifier Diode)

6. Directions: Label the following components in the amplifier circuit shown below. Resistor (R), Speaker (LS), Transistors (Q), Transformer (T).



Answers to Self-Test:

1. Transistor
2. Coupling Circuits
3. Transistor
4. Resistor
5. Rectifier Diode
6.



The exact number of the resistors may vary.

FINAL QUIZ IS AN INDUSTRY DRAWING!

Study Guide

For Further Information:

Electrical and Electronics Diagrams; The American Society of Mechanical Engineers, ANSI Y14.15, 1969.

Electronic Drafting and Design, Raskhodoff, 1972.

Electrical and Electronics Drawings, Baer, 1973.

ILS Drafting: Electrical/Electronics, articles 26.50; 26.70

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Drafting

Interconnection or Block Diagrams

Component Symbols **Conductors**

Point to Point Connection Diagrams

Cable or Highway Diagrams

Baseline Connection Diagrams

Goal:

The student will be able to trace the circuits in different types of electrical diagrams.

Performance Indicators:

Given schematic diagrams of three different types of electrical circuits, the student will trace the circuits.

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Introduction

INTRODUCTION:

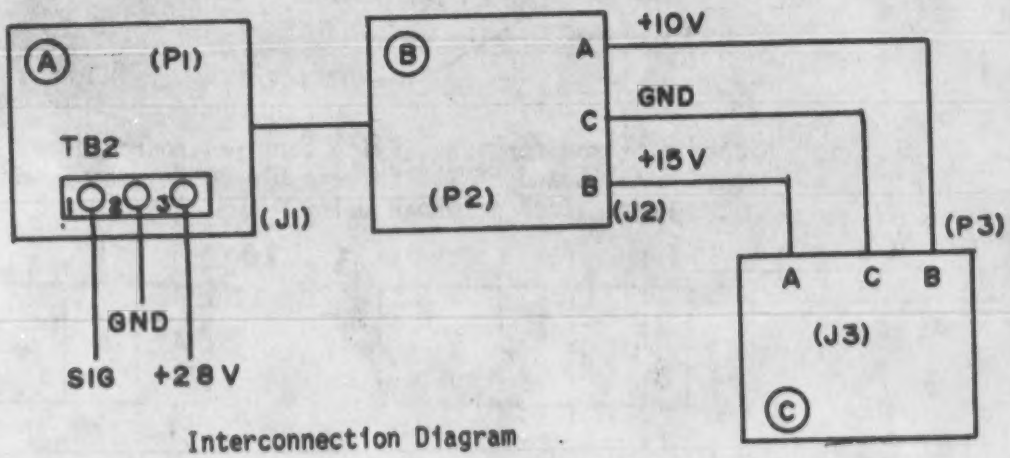
The schematic diagram provides only the basic circuit connection information. It is not complete enough for servicing or assembling the circuit on a production basis. A companion diagram to the schematic is the connection diagram. It provides detailed wiring information in terms that service or assembly technicians can use.

There are two situations that require connection diagrams. They are the interconnection diagram or "block" diagram, which shows the external wiring between separate pieces of electronic equipment, and the component wiring diagram, which shows the wiring of the internal components.

Information

1. INTERCONNECTION OR "BLOCK" DIAGRAMS

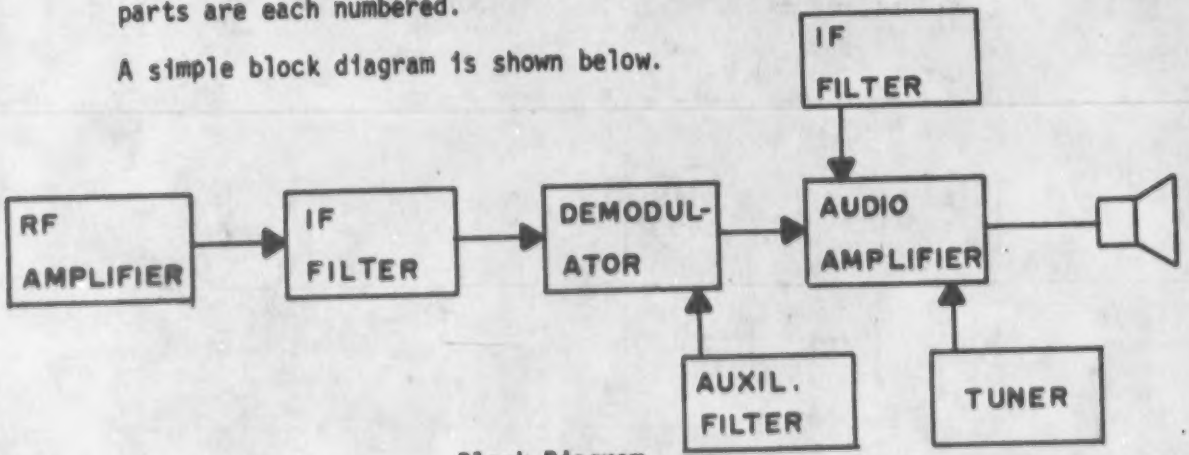
The external wiring connections between separate electronic equipments is the primary purpose of the interconnection diagram. Therefore, the electronic equipment is simplified by a symbol such as a square or rectangle. The only components that are shown in the blocks are the terminal connections or terminal boards. Each block is named and the terminals and terminal boards are numbered. An example is shown below. In this case, the blocks are identified by the letters "A," "B" and "C."



Interconnection Diagram

Notice that the plugs and jacks for connections between these parts are each numbered.

A simple block diagram is shown below.



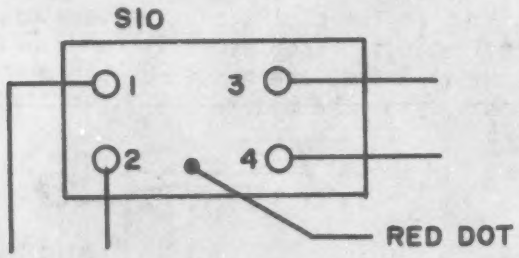
Block Diagram

2. COMPONENT SYMBOLS

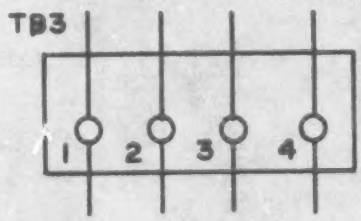
Depending on their physical complexity, components are represented on the connection diagram in a number of ways. Basic geometric shapes, such as circles, squares and rectangles are used as the basic component symbols.

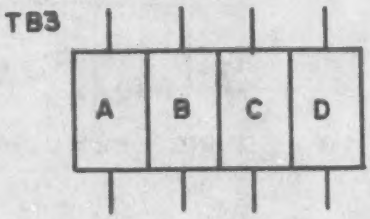
Terminal connections for each component must be adequately identified. They are normally represented as they would appear on the component. Reference points are often shown as an aid in identifying connectors.

In the example below, the words "red dot" are given as reference in information.

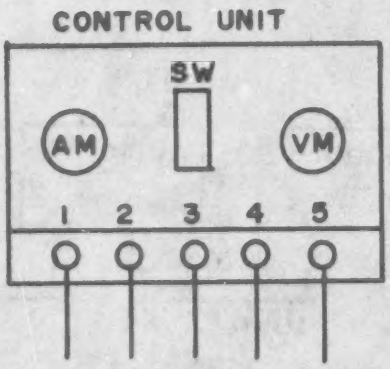


A common method for identifying terminal boards is to number the terminal board "TBZ," for example. They may be drawn in two ways. Each is shown below.





Component symbols may also represent assemblies.



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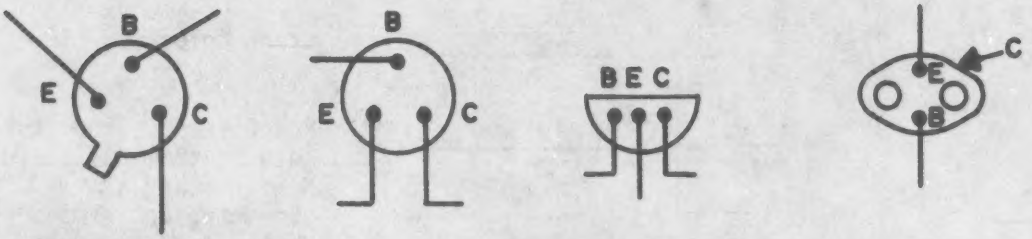
Transistor components are shown as if viewed from the bottom. Letters "E," "B" and "C" are used to identify the emitter, base, and collector respectively. Each connection point is numbered. Some examples are shown below.



3. CONDUCTORS

Round copper wire sizes are identified by numbers in accordance with American Wire Gage (AWG) Standards.

Sizes #10 through #42 are most common in electronic equipment.

"Bus wire" is a solid, tinned copper wire used for short point to point connections.

The most common conductor used in electronic wiring is the single, plastic coated, copper wire. This wire is available in a variety of solid colors or solid color with a single or double "tracer" winding around it.

Conductors are identified by a coding system which may include color or colors, wire size or other information about the conductor.

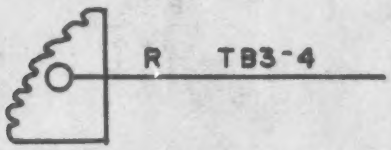
Conductor Color Abbreviations

Color	Code	Abbreviation	Military Standards
Black	0	BK	BLK
Brown	1	BR	BRN
Red	2	R	RED
Orange	3	O	ORN
Yellow	4	Y	YEL
Green	5	G	GRN
Blue	6	BL	BLU
Violet	7	V	VIO
Gray	8	GY	GRA
White	9	W	WHT

Some of the basic conductor identifications are shown below. Number 1 indicates seven strands of Number 30 wire in solid green covering.

(1) 7/30 G

(2) G — Green Color Covering

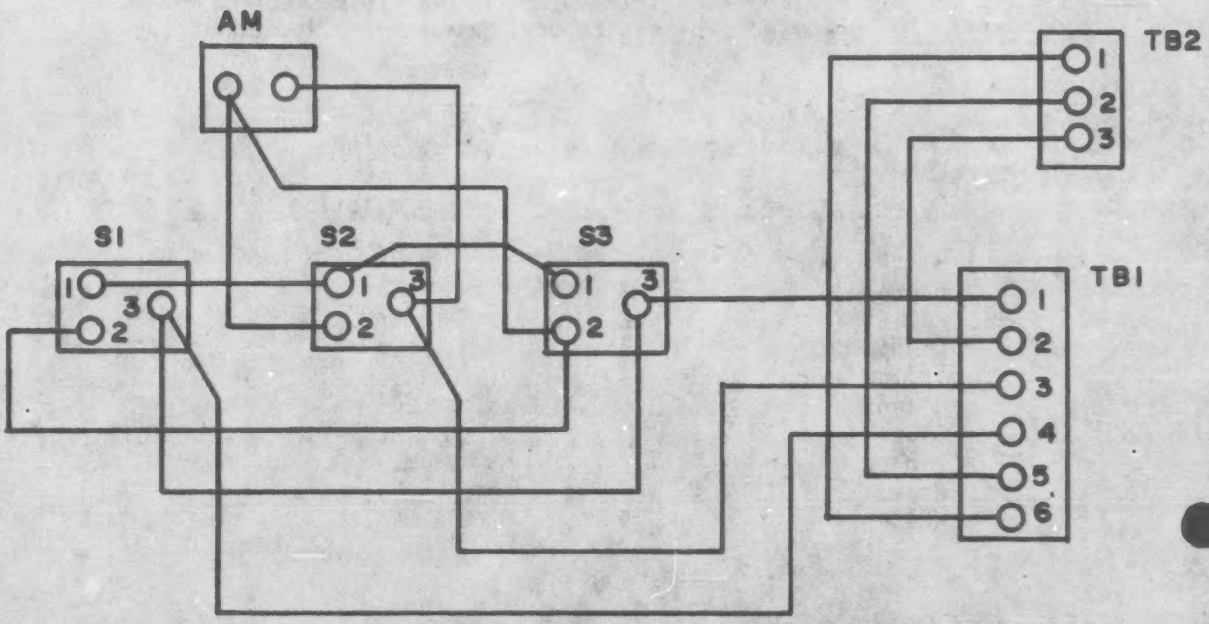
(3) 

Red Covering-Conductor goes to terminal board Number 3 and is connected to terminal Number 4.

4. POINT-TO-POINT CONNECTION DIAGRAMS

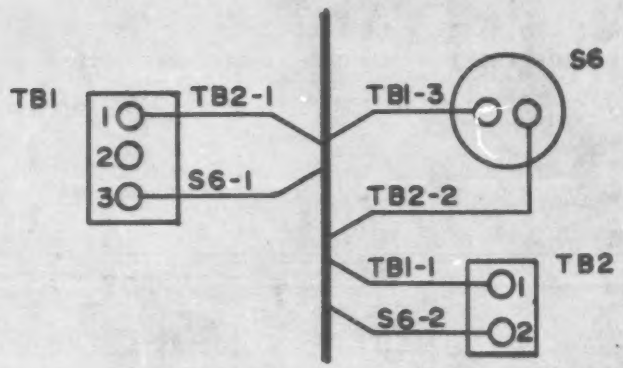
For simple electronic circuits, it may be possible to show a wire-by-wire connection of components. However, this is normally accomplished by showing the components as they would appear in the circuit or as they would be placed on a mounting assembly or chassis.

Point-to-point connection diagrams may be actual pictorial drawings for service manuals; or they may be in the form of single-line drawings, as those used for schematics.



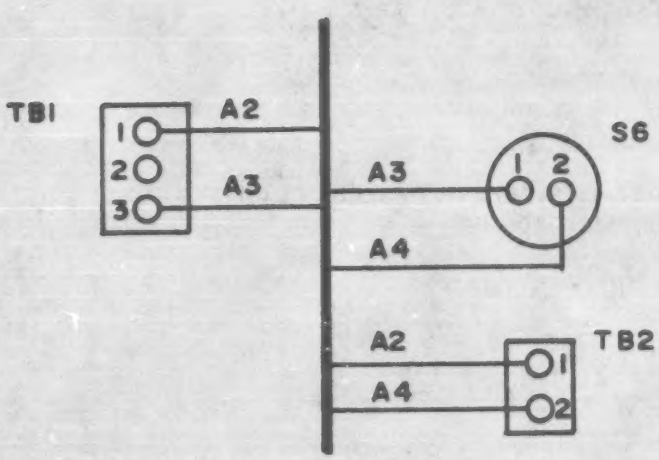
5. CABLE OR HIGHWAY CONNECTION DIAGRAMS

When diagrams become too complex to be drawn as point-to-point diagrams, a number of the connections may be merged into single lines that run horizontally and vertically between the components. These lines are connected to the components by short lines called "feed" lines. The example below shows one method of feed line information. The destination of the feed line is shown by a component designation letter and number. The feed lines may also bend or curve in the direction of that component.



Wire Color Codes May Also Be Included

If a large amount of information about conductors is necessary, then a conductor identification letter and number may be used to identify each conductor. A list of these conductors and the necessary information about them would also be on the drawing.

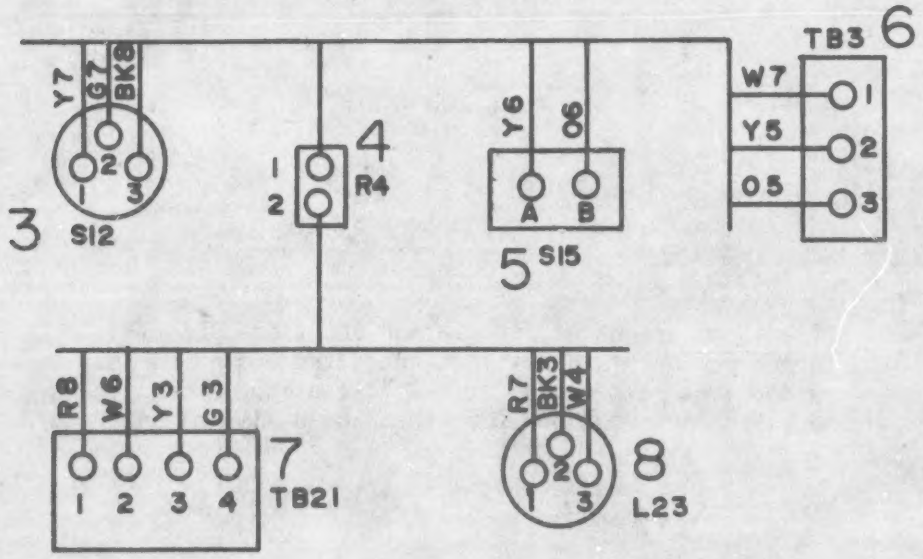


6. BASE-LINE CONNECTION DIAGRAMS

Unlike the cable diagram, a base-line connection diagram may have several short base lines that help simplify the connection diagram. Components in a base-line connection diagram are assigned numbers from left to right and top to bottom.

It should be noted that the base lines, like the cable or highway, are only for the convenience of the reader. They don't actually exist in the circuit. Base lines may or may not be continuous.

In the example below, trace the black wire from terminal board 2, terminal board 3 to its destination (switch 12 or component number 3).



Notice that the terminal is determined by the color of conductor coming into that component.

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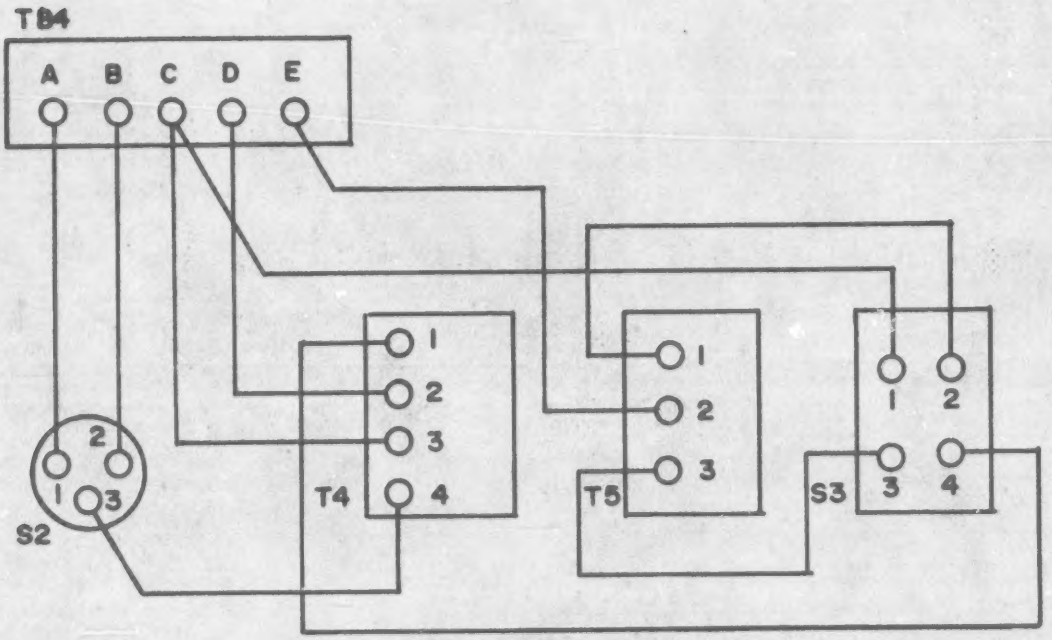
Self Assessment

Directions: From the point-to-point diagram below, give the component name and terminal number that is connected to the following components and terminals.



1. Terminal C of terminal board 4 is connected to _____ _____ terminal _____ and _____ terminal _____.

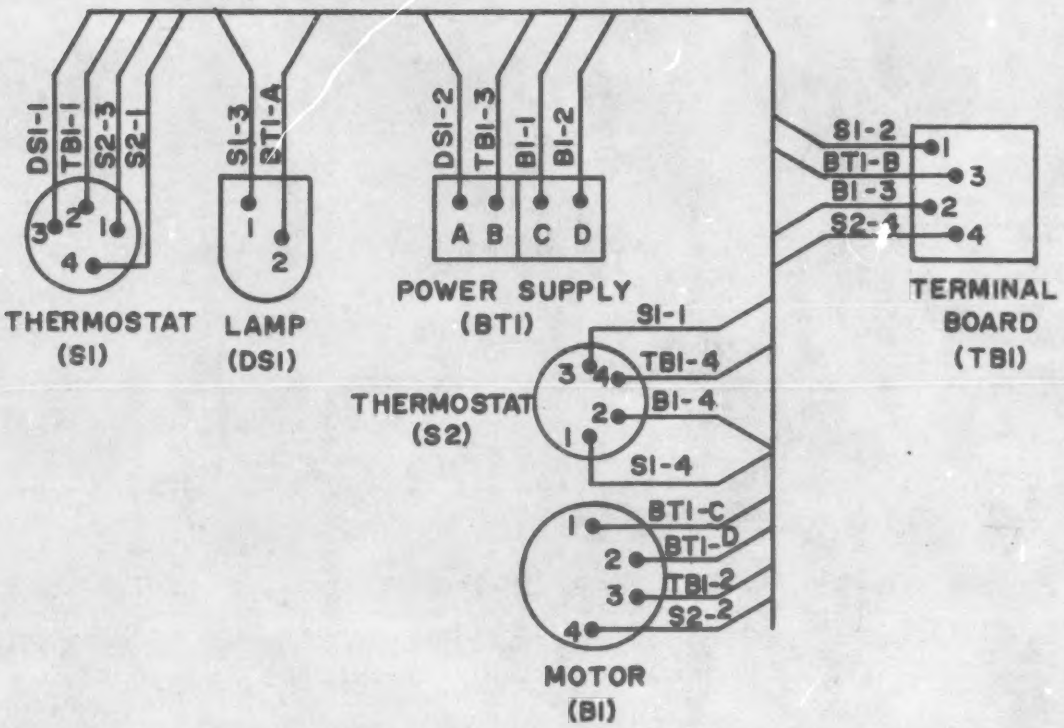
2. Terminal 3 of switch 3 is connected to _____ terminal _____.

3. Terminal 1 of transformer 4 is connected to _____ terminal _____.

4. Terminal E of terminal board 4 is connected to _____ terminal _____.

5. Terminal 1 of transformer 5 is connected to _____ _____ terminal _____.

Directions: From the highway connection diagram below, indicate the component and terminal number that is connected to the following components and terminals.



1. Terminal 3 thermostat 1 is connected to _____ terminal number _____.

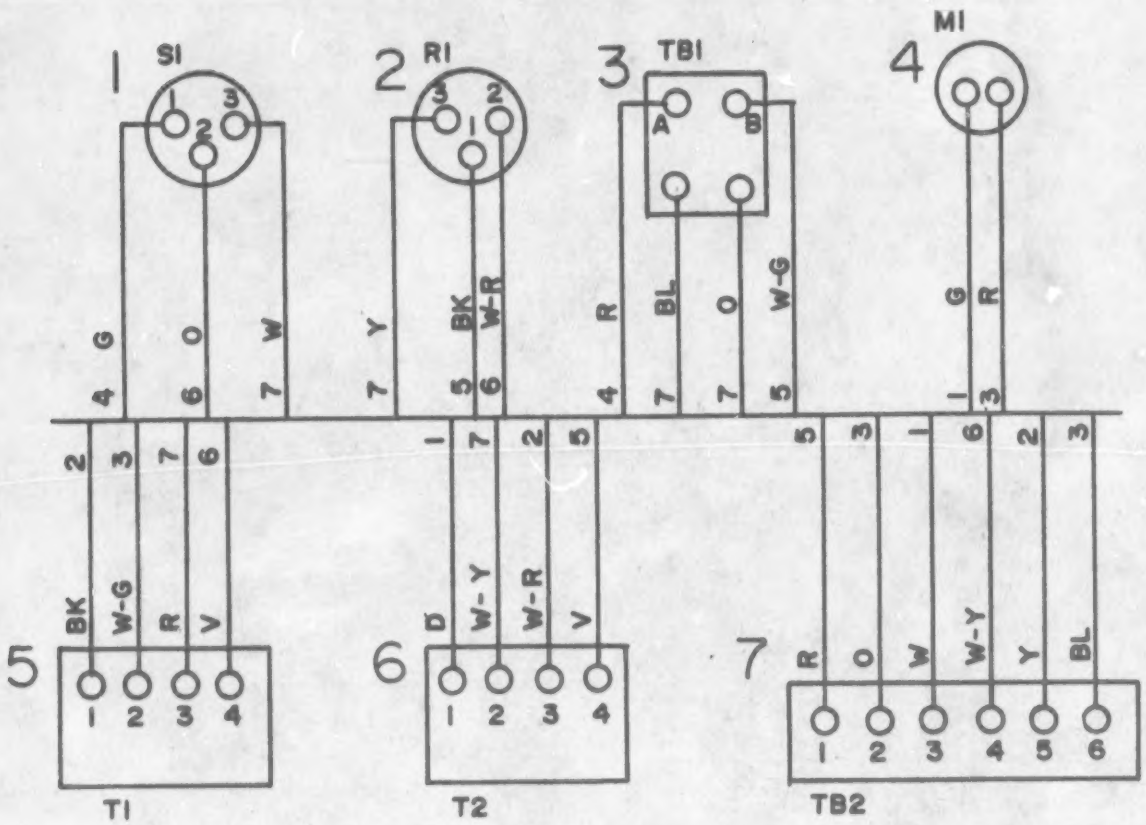
2. Terminal B of battery 1 is connected to _____ terminal number _____.

3. Terminal 2 of terminal board 1 is connected to _____ _____ terminal number _____.

4. Terminal 4 of thermostat 1 is connected to _____ terminal number _____.

5. Terminal 1 of motor 1 is connected to _____ terminal number _____.

Directions: From the base-line connection diagram below, indicate the component and terminal number that is connected to the following components and terminals.



1. Terminal 5 of terminal board 2 is connected to _____ _____ terminal number _____.

2. Terminal 1 of switch 1 is connected to _____ terminal number _____.

3. Terminal B of terminal board 1 is connected to _____ _____ terminal number _____.

4. Terminal 3 of transformer 1 is connected to _____ _____ terminal number _____.

5. Terminal 6 of terminal board 2 is connected to _____ _____ terminal number _____.

Answers next page

Answers to Self-Test:

Answers to Point-to-Point Diagram

1. Transformer 4, Terminal 3, and Switch 3, Terminal 1.
2. Transformer 5, Terminal 3.
3. Switch 3, Terminal 4.
4. Transformer 5, Terminal 2.
5. Switch 3, Terminal 2.

Answers to Highway Connection Diagram

1. Lamp 1, Terminal 1.
2. Terminal Board 1, Terminal 3.
3. Motor 1, Terminal 3.
4. Thermostat 2, Terminal 1.
5. Power Supply 1, Terminal C.

Answers to Base-line Connection Diagram

1. Resistor 1, Terminal 3.
2. Motor 1, Terminal 1.
3. Transformer 1, Terminal 2.
4. Terminal Board 2, Terminal 1.
5. Terminal Board 1, Terminal C.

FINAL QUIZ IS AN INDUSTRY DRAWING!

Study Guide

For Further Information:

Electrical and Electronics Diagrams; The American Society of Mechanical Engineers, ANSI Y14.15, 1969.

Electronic Drafting and Design, Raskhodoff, 1972.

Electrical and Electronics Drawings, Baer, 1973.

92

Post Assessment

Advanced Print Reading

Final Quizzes

Name_____

Directions: Identify the following symbols and symbol modifiers.

1. _____

2. _____

3. _____

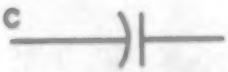
4. _____

5.

_____

6.

_____

7. 

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8.

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9. _____

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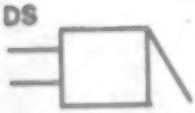
12.

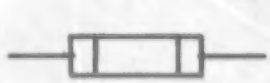
13. 

14.

15.

Name_____

Directions: Identify the following symbols.

1. 

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2.

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3.

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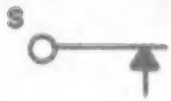
4. 

_____

5.
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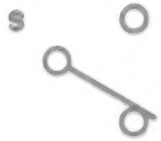
6. 

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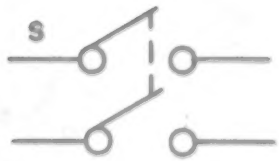
7. 

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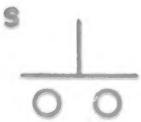
8. 

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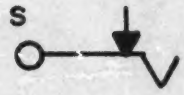
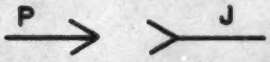
9. 

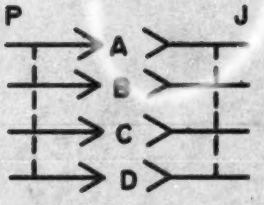
10.

11.

12.

13.

14. 

15. 

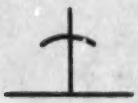
97

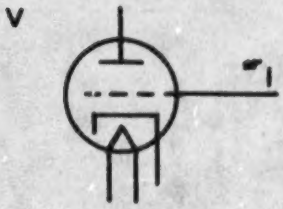
Name_____

Directions: Identify the following symbols and symbol elements.

1. _____

2. _____

3.  _____

4. 

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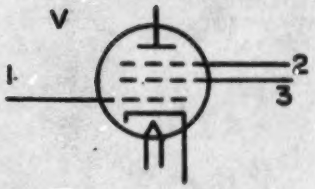
5. 

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6.

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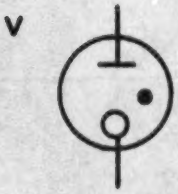
7. 

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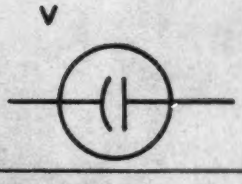
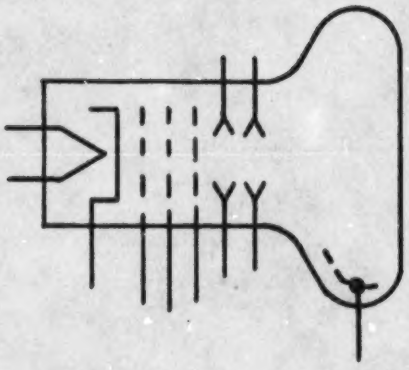
8. 

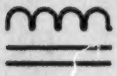
_____

9. 

Name_____

Directions: Identify the following symbols.

1. _____

2.  _____

3. _____

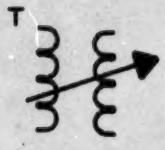
4. _____

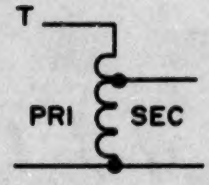
5. _____

6. _____

7. _____

100

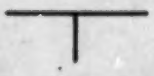
8. 

9. 

101

Name_____

Directions: Identify the following symbols and symbol elements.

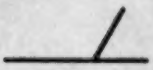
1.  _____

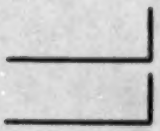
2. _____

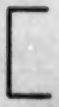
3. _____

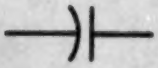
4. _____

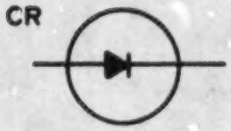
5. _____

6.  _____

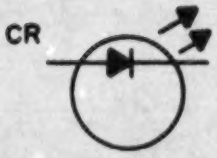
7.  _____

8.  _____

9.  _____

10. 

11.

12. 

13.

14.

15.

Name_____

Directions: Identify the following symbols.

1.

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2.

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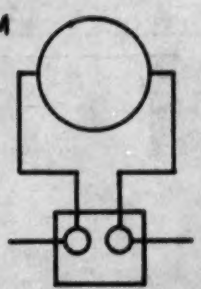
8. 

_____

9. G

_____

10. B

_____

105

Name_____

Directions: Refer to the Industrial Drawing marked EL1, to answer the following questions.

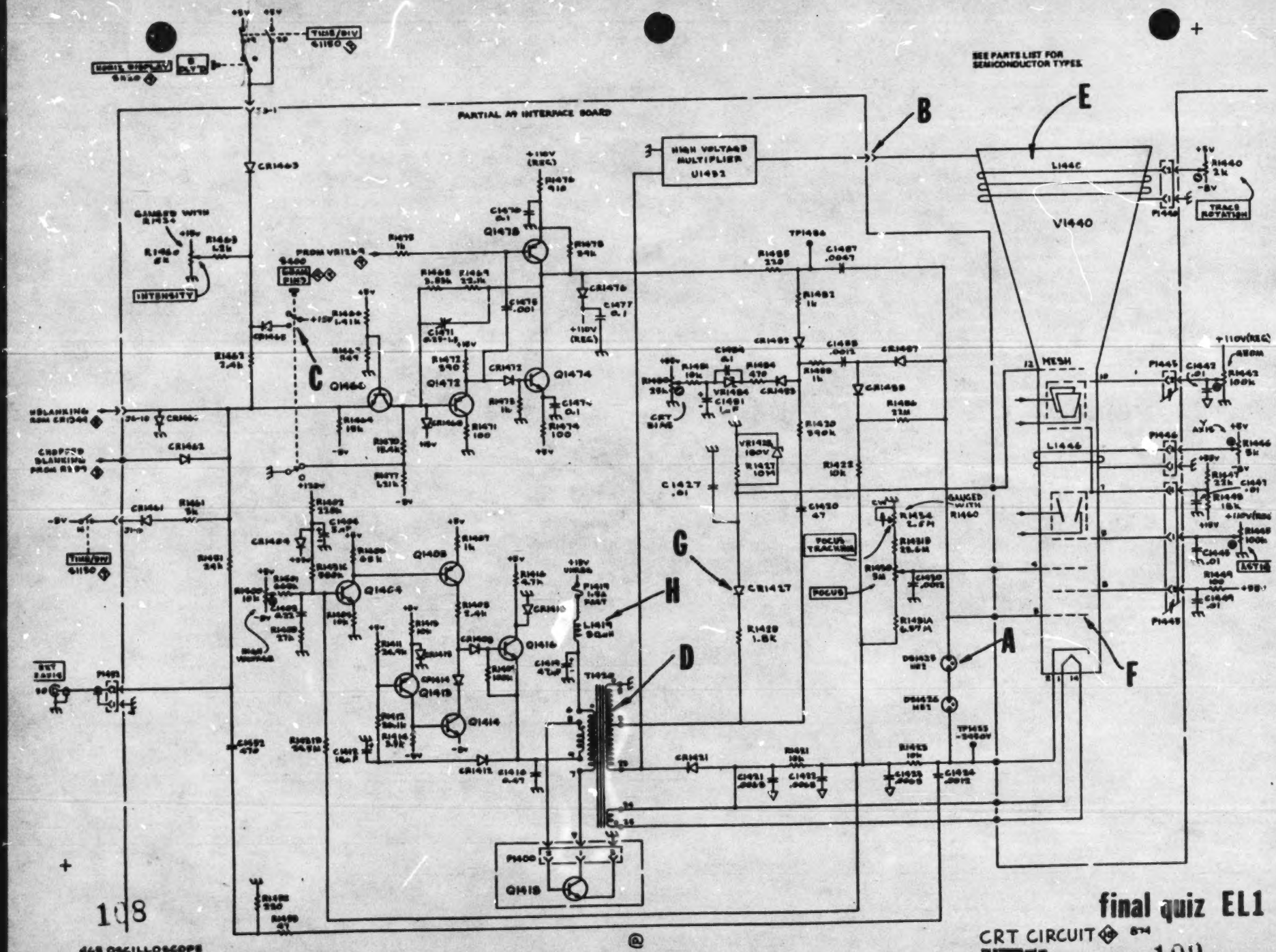
1. What type of resistor is R1440? _____
2. What is the component at (A) ? _____
   _____
3. How many semiconductors are shown? _____
4. What is the symbol at (B) ? _____
5. What is the ohm rating of resistor 1422? _____
6. What is the component at (C) ? _____
   _____
7. What is the component at (D) ? _____
   _____
8. What is the component at (E) ? _____
   _____
9. What is the name of the component element shown at (F) ?
   _____
10. What is the rating of capacitor 1412? _____
11. What type of capacitor is C1471? _____
    _____
12. What is the ohm rating of resistor 1486? _____
13. What is the component at (G) ? _____
    _____
14. What is the component at (H) ? _____
    _____
15. What is the component number for the CRT? _____

106

Name_____

Directions: Refer to the Industrial Drawing marked EL2, to answer the following questions.

1. The channel two preamp is connected to _____ _____, _____ and _____.
2. The vertical output amp is connected to an element of the _____.
3. The low voltage power supply is connected to _____ _____.
4. Signal from the delay line goes to _____ _____.
5. Component number 11 is connected to _____ _____.
6. Name the two component elements that the CRT circuit is connected to _____ _____.
7. Name the components that are connected to the sweep control and Z axis logic._____ _____ _____



final quiz EL1

CRT CIRCUIT 674

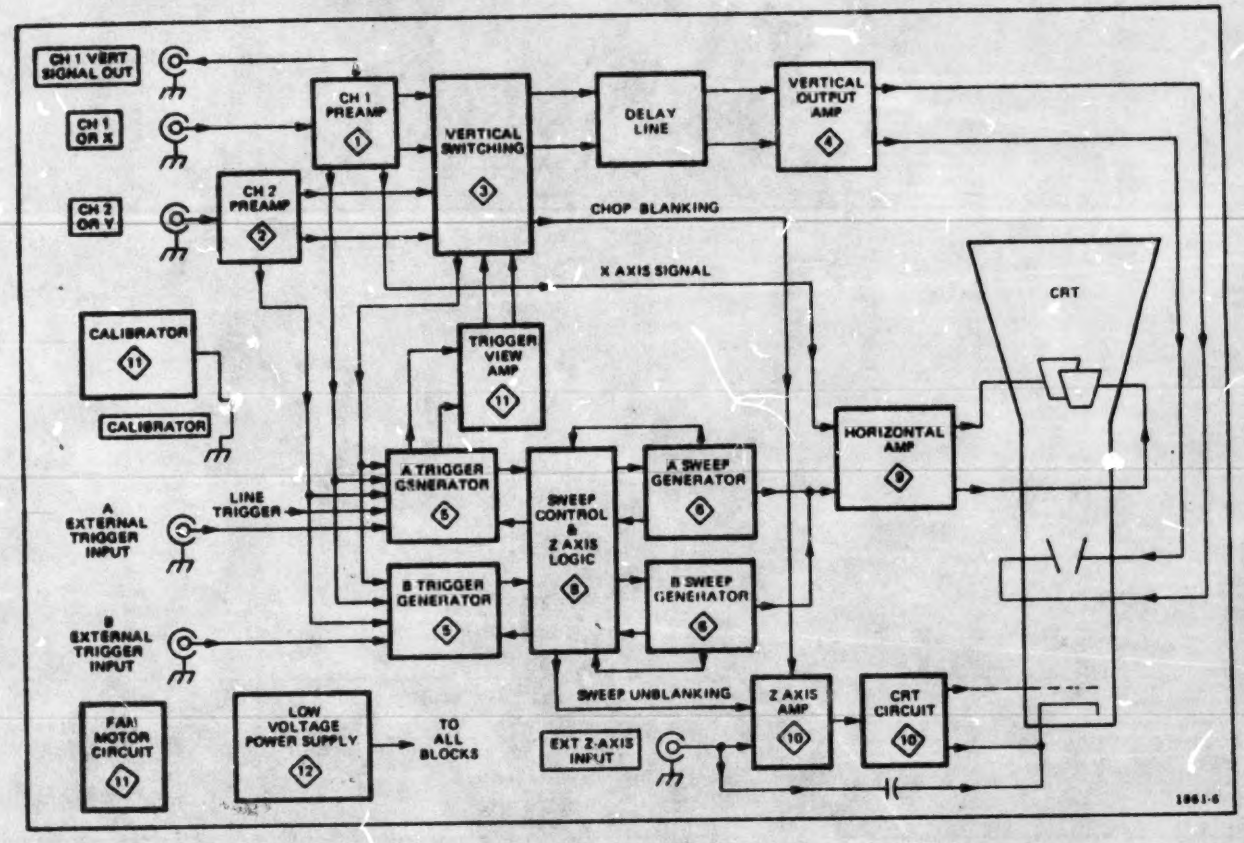


Fig. 3-1. Basic block diagram of the 465.

final quiz EL2